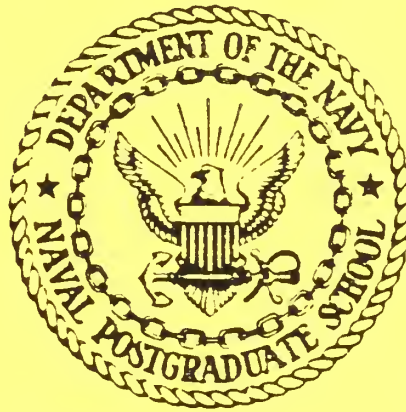


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NAVAL POSTGRADUATE SCHOOL

Monterey, California



MIZEX 87 Meteorology Atlas

by

Peter S. Guest and Kenneth L. Davidson

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NAVAL POSTGRADUATE SCHOOL
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MIZEX 87 METEOROLOGY ATLAS

March 21st, 1988

Peter S. Guest and Kenneth L. Davidson

Environmental Physics Group
Naval Postgraduate School
Monterey CA 93943-5000

Abstract

The 1987 Marginal Ice Zone Experiment (MIZEX 87) was a multi-national interdisciplinary project in the Fram Strait from 19 March to 11 April 1987. Surface and upper-level measurements of meteorological parameters were obtained from three ships, the *R/V Polar Circle*, the *R/V Haakon Mosby* and the *R/V Valdivia*. This atlas contains:

1. Time series of surface wind velocity, pressure, relative humidity and temperature from the ships.
2. Maps showing six-hour averages of the locations of the ships and ice edge, and surface wind velocity vectors at the ships.
3. High-resolution profiles of wind, temperature and humidity up to 2500 m.
4. Maps of sea-level pressure every 12 hours.

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Introduction

The 1987 Marginal Ice Zone Experiment (MIZEX 87) was the third and final of the MIZEX experiments. After MIZEX 84, a Meteorological atlas was prepared by Ron Lindsay. This was the most requested MIZEX document which was archived at the National Snow and Ice Data Center in Boulder CO. Therefore, we have prepared a similar atlas for MIZEX 87 which should be valuable for various Marginal Ice Zone (MIZ) research needs. The emphasis of this atlas is on surface and boundary-layer meteorology. This is the part of the atmosphere which is most important for air-ice-ocean interactions which are so crucial in the MIZ. A separate atlas of upper atmosphere data also will be prepared. We have combined various data sources by chronological order so that a researcher can find all the information for a particular time period near each other in the atlas. After this introduction, the various data sources will be listed along with a discussion of the data quality. Then, the various figures used to present the data will be explained and finally the figures themselves are shown.

Data sources and error analysis

The data presented here were obtained from three research vessels and the Norwegian Meteorological Institute in Tromsø, Norway. The three ships were the *R/V Polar Circle* (Reiber Shipping, Alesund, Norway), the *R/V Haakon Mosby* (University of Bergen, Bergen, Norway) and the *R/V Valdivia* (University of Hamburg, Hamburg, F.R. Germany). The accuracies referred to below were absolute and were based on manufacturer's claims, field experience and knowledge of the locations of the instruments. It was likely that there were occasional periods when the measurements had errors greater than the stated accuracies; we do not guarantee the accuracy of these data. The sensitivity of the measurements was generally at least ten times better than the absolute accuracy.

Polar Circle

The *Polar Circle* collected data from 22 March through 11 April 1987. The surface data were collected from a Coastal Climate (Seattle, WA) met station mounted on a platform which extended forward from a bow mast at a level of 16 meters above sea level. There were problems with the wind speed as measured by the met station when the wind speed was greater than 9 m/s. During these periods, wind speeds were obtained from a sonic anemometer located at the same location. There was excellent agreement (within 0.3 m/s) between these sensors at lower wind speeds; therefore reported speeds should be accurate to at least this amount. The errors associated with ship distortion effects were believed to be less than 5% because of anemometer locations well away from blocking structures. An exception was when the wind was directly from the stern, when errors may have been as great as 20%. The temperature was estimated to be accurate to 0.2 °C and the relative humidity to within 5%.

All winds were corrected for ship motion based on the ship's speed and heading. A compass on the met station was used to determine ship heading. This was routinely compared to the ship gyroscope reading to correct for magnetic anomalies caused by the ship and local geology. Unfortunately, the ship caused extreme magnetic distortion for certain headings so that there was occasionally considerable error in the true wind directions between the times when the gyroscope heading was recorded. When the *Polar Circle* was near the *Haakon Mosby* the wind direction from the latter should be used. Most of the time, the wind directions from the *Polar Circle* were accurate to within 20 degrees. This problem did not affect the true wind speed calculations.

Vertical profiles of temperature, humidity and winds were obtained from rawinsondes manufactured by the VIZ corporation using software developed by Chris Vaucher. The vector winds were determined from an omega navigation system on the rawinsondes and were usually accurate to 1.0 m/s. In regions of strong vertical shear, errors may increase to 2.0 m/s. The temperature and dewpoint temperature were accurate to 0.2 °C and 1.0 °C, respectively, while the heights were accurate to 30 m. Rawinsonde measurements are instantaneous and do not necessarily represent the average conditions, particularly when strong secondary circulations are present.

Haakon Mosby

The *Haakon Mosby* had a met station at 18 meters elevation with the same instruments as the *Polar Circle* and similar accuracies of all parameters as stated above except for wind direction. At higher wind speeds, wind speed was obtained from a miniature cup anemometer designed by Paul Frenzen (Argonne National Laboratory, IL). The ship did not cause extreme distortion of the magnetic field; therefore wind directions were usually accurate to within 5 degrees. During a few periods when the wind was from the stern of the ship, flow distortion may cause 20% errors in wind speed and direction. Both the *Polar Circle* and the *Haakon Mosby* data were sampled at least once every 12 seconds and ten minute averages are presented here.

The rawinsondes launched from the *Haakon Mosby* were manufactured by the Vaisala Corporation using a system developed by Roger Helvey. Omega navigation was used for winds. Accuracies were similar to the *Polar Circle* except that winds in the lowest 500 meters had to be interpolated from surface and upper-level values. Humidity was probably less accurate than the other ships.

Valdivia

The *Valdivia* obtained the same parameters discussed above except that there was no surface humidity measurement. There was a problem recording the correct time; therefore we have used only data during observation periods when the time was known. This was usually every three hours. The accuracies of the values of the various parameters were similar to the *Haakon Mosby*.

The rawinsonde system on the *Valdivia* was virtually identical to the *Polar Circle* system and had the same accuracies.

Pressure

The pressures from the *Polar Circle* and the *Haakon Mosby* shown on the time series plots were automatically recorded. These automatic (but less accurate) pressure sensors were calibrated in the field by comparison with Tromso pressure and an accurate pressure sensor on the *Polar Circle* (borrowed from R. Helvey) which was manually recorded. The automatic pressure recorders (which are shown in the time series plots) had some drift. When this was corrected in the field, the pressure values plotted show a sudden jump which was not realistic. The pressure readings shown in the time series may have an error of 2 millibars. A more complete comparison of pressure sensors which would increase the accuracy has not yet been done.

Surface Analyses

The sea-level pressure analysis was copied from the analysis performed by the Norwegian Meteorological Institute in Tromso, Norway. This was a "quick" analysis and not all data were available when the analyses were made. There were undoubtedly errors in the analysis of this data-poor region.

Explanation of figures

The following figures are shown in this atlas:

1. Time series of surface wind velocity, pressure, relative humidity and temperature from the ships.
2. Maps of surface pressure every 12 hours.
3. Maps showing six-hour averages of the locations of the ships and ice edge, and surface wind velocity vectors at the ships.
4. High-resolution profiles of wind, temperature and humidity up to 2500 m.

The time period covered is from 19 March through 11 April 1987. There are no data from the *Polar Circle* or the *Haakon Mosby* until 23 March and no data from the *Valdivia* after 3 April. The first figure is a time series of the entire period from 22 March through 11 April. After the one page of the long time series the figures are arranged in the following order with one page per listed item:

- Three-day time series
- Surface analysis for 0000 UTC on the first day.
- Surface analysis for 1200 UTC on the first day.
- Wind vector and location of all ships at 0000, 0600, 1200, 1800 UTC on the first day.
- Rawinsonde data from launches nearest the above times from the *Polar Circle*.
- Rawinsonde data from launches nearest the above times from the *Haakon Mosby*.
- Rawinsonde data from launches nearest the above times from the *Valdivia*.
- Surface analysis for 0000 UTC on the second day.
- Continues until the third day is finished, then repeat again with next three days.

Therefore, the atlas is arranged so that each figure is associated with other figures from that same day except for the time series which is only shown every third day.

All the times on the figures represent Universal time, which is often referred to as "Greenwich mean time" or "Z-time." Unfortunately, the labelling is inconsistent; the vector plots, surface analyses and rawinsonde profiles use "Z", "UT" and "GMT", respectively, which are identical in meaning and all should have been labelled "UTC".

Time series

The wind direction on the time series plots is indicated by a bar pointing into the wind. Therefore, a wind from the west is indicated by a bar pointing to the left. Oceanographers beware! This is opposite the way currents are represented. The *R/V Polar Circle* the *R/V Haakon Mosby* and the *R/V Valdivia* are labelled PC, IIM and VL, respectively, on the time series plots. Missing data are shown as gaps in the plots.

Surface analysis

The surface pressure maps have isobars every 5 millibars and only the last two whole digits of the pressure values are used in the labels. Cold fronts are indicated by solid triangles, warm fronts by solid semi-circles and occluded fronts alternate these.

Vector winds and ships' locations

The plots of ship location and wind velocity vector were based on averages of all data available three hours before and after the time indicated. The average location of each of the ships was indicated by a circle, a square or a triangle for the *Polar Circle*, *Haakon Mosby* or *Valdivia*, respectively. **Beware! Unlike the time series and rawinsonde profiles, the vectors on these figures point downwind.** The distance from the center of the ship symbol to the tip of the arrowhead on the velocity vector is proportional to the wind speed. A wind speed scale is shown on the bottom of the 0000 UTC figure. When no vector is shown, either or both the wind vector or location was not available for that ship during that time period.

The approximate 50% pack ice cover line is drawn as an indication of the ice edge location. This was copied from the charts which were prepared especially for MIZEX 87. More accurate ice edge locations are probably available from other sources for many time periods. The ice edges are shown here to give the reader a general idea of the location of the ships with respect to the ice and should not be used for studies requiring precise ice information.

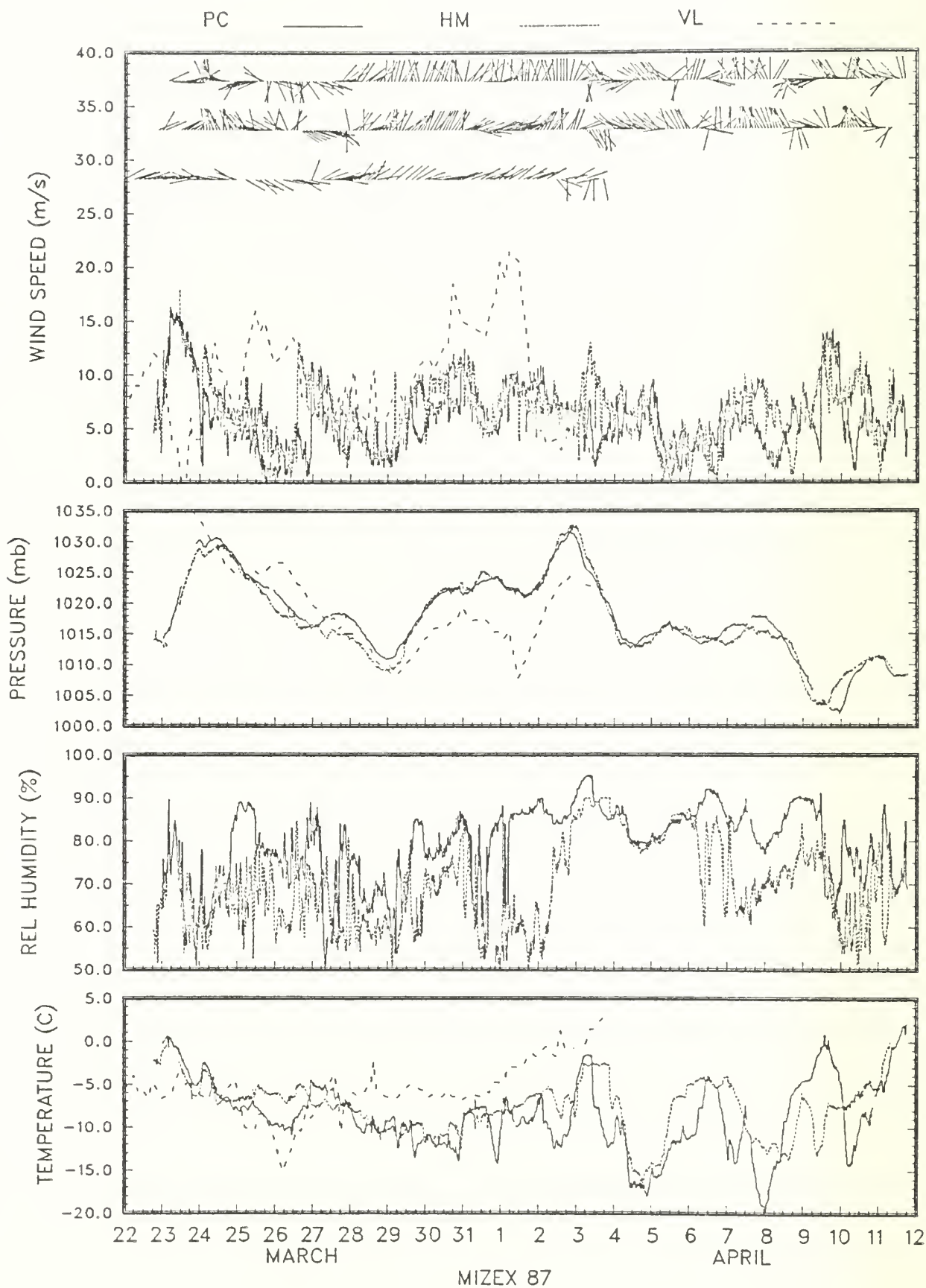
Rawinsonde profiles

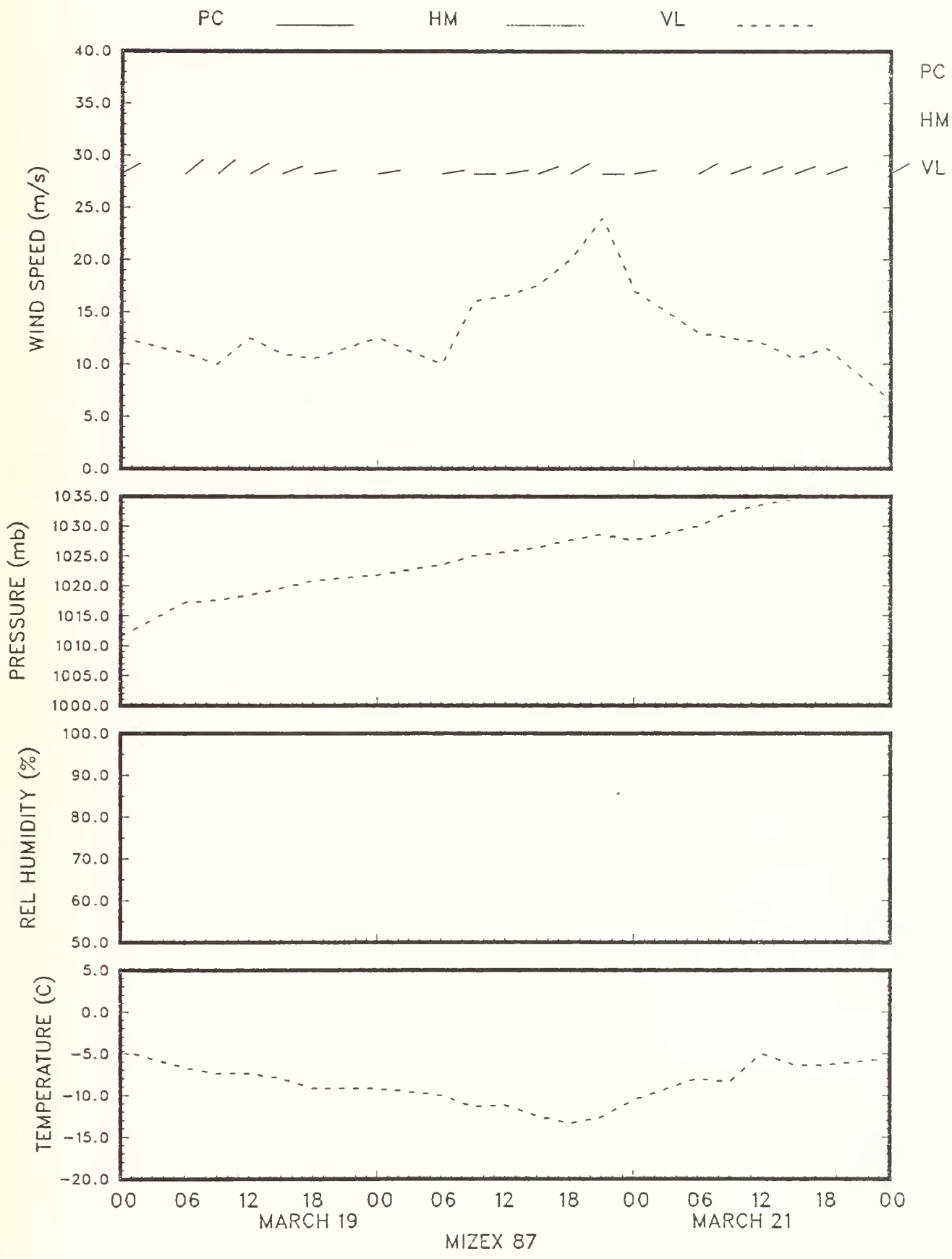
The rawinsonde profiles show potential temperature and humidity on one plot, and wind speed and direction on an adjacent plot with the same height scale. The potential temperature is shown as a thick solid line. This was calculated by adding 0.00976 times altitude to the measured temperatures. This is a conserved quantity (Moving an air parcel up or down does not change its value.) and therefore it will be plotted as a vertical line when vertically well-mixed. (Actually, this is strictly true only when no liquid water drops exist.) Humidity is shown in two curves, representing two ways of expressing the same physical property. The potential dewpoint (dashed line) is determined from the measured dewpoint, by using the same method described above for potential temperature. The specific humidity (thin solid line) represents the mass ratio of water vapor to air and is a conserved quantity. The potential dewpoint temperature is plotted so that the location of clouds can be easily determined. Clouds or fog occurred when the potential temperature and potential dewpoint temperature were the same. No single humidity variable can easily show the location of clouds **and** mixed layers. This is the reason that two different parameters describing the same physical property are shown.

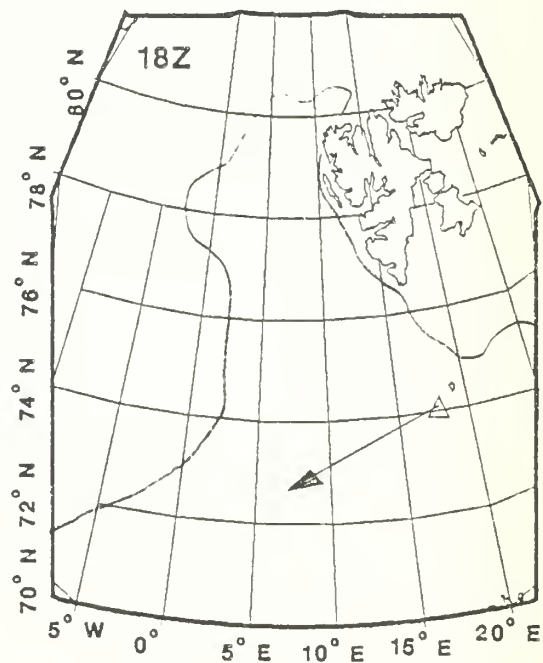
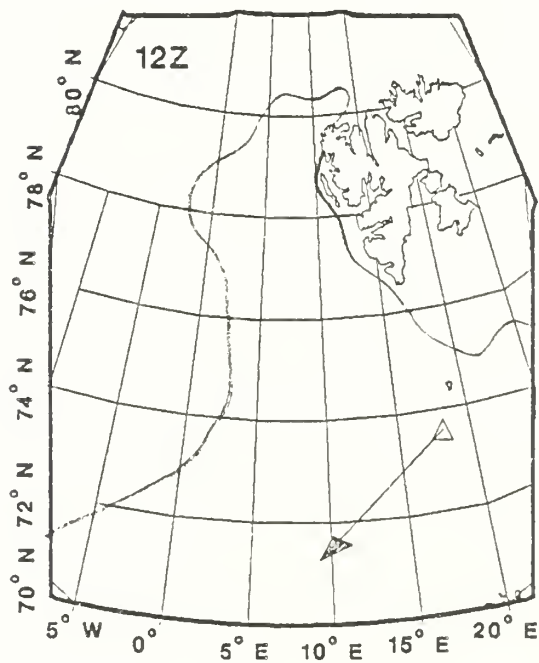
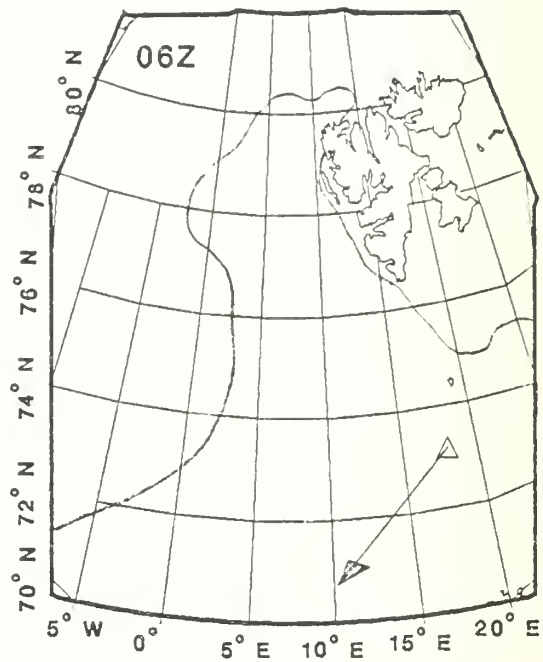
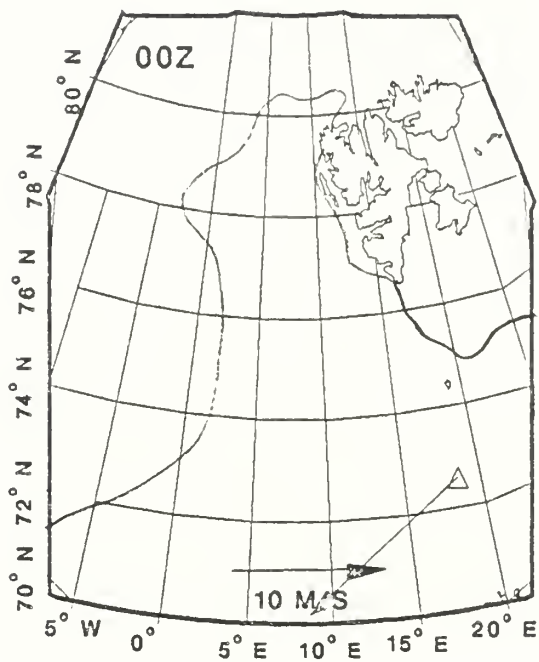
The wind directions are shown using bars pointing **into** the wind. All the wind direction bars start along an imaginary vertical line above the "20 m/s" label and end in the direction of the wind with vertical upward representing from the north, to the right representing from the east, etc. Universal time (labelled "GMT") is used on these and all other figures. The time and location represent values when the balloon was released.

Profiles from each ship are shown on separate pages. There are four plots on each page, corresponding to approximately 2300 UTC (previous day), 0500 UTC, 1100 UTC

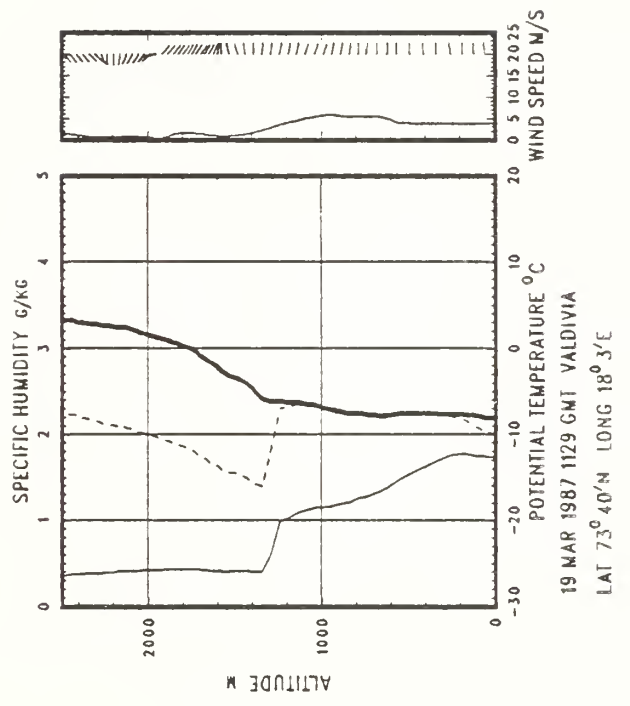
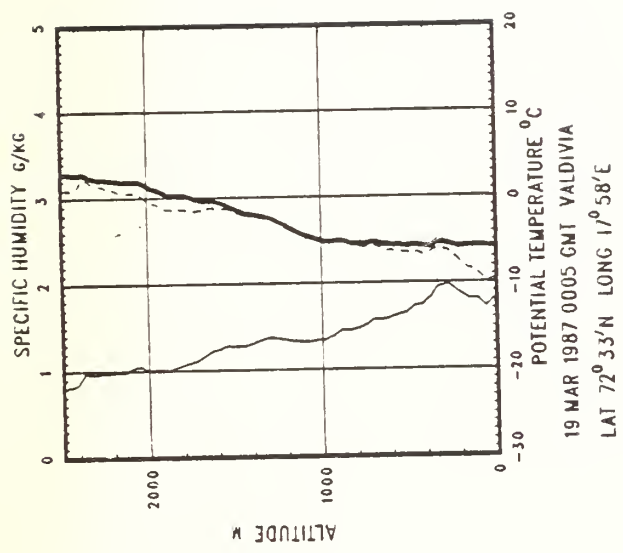
and 1700 UTC. If a profile was not available, then the location for that time is left blank. Sometimes only winds were not available, in which case the wind plot area was left blank. If no profiles were available for the entire day, then the page is skipped.

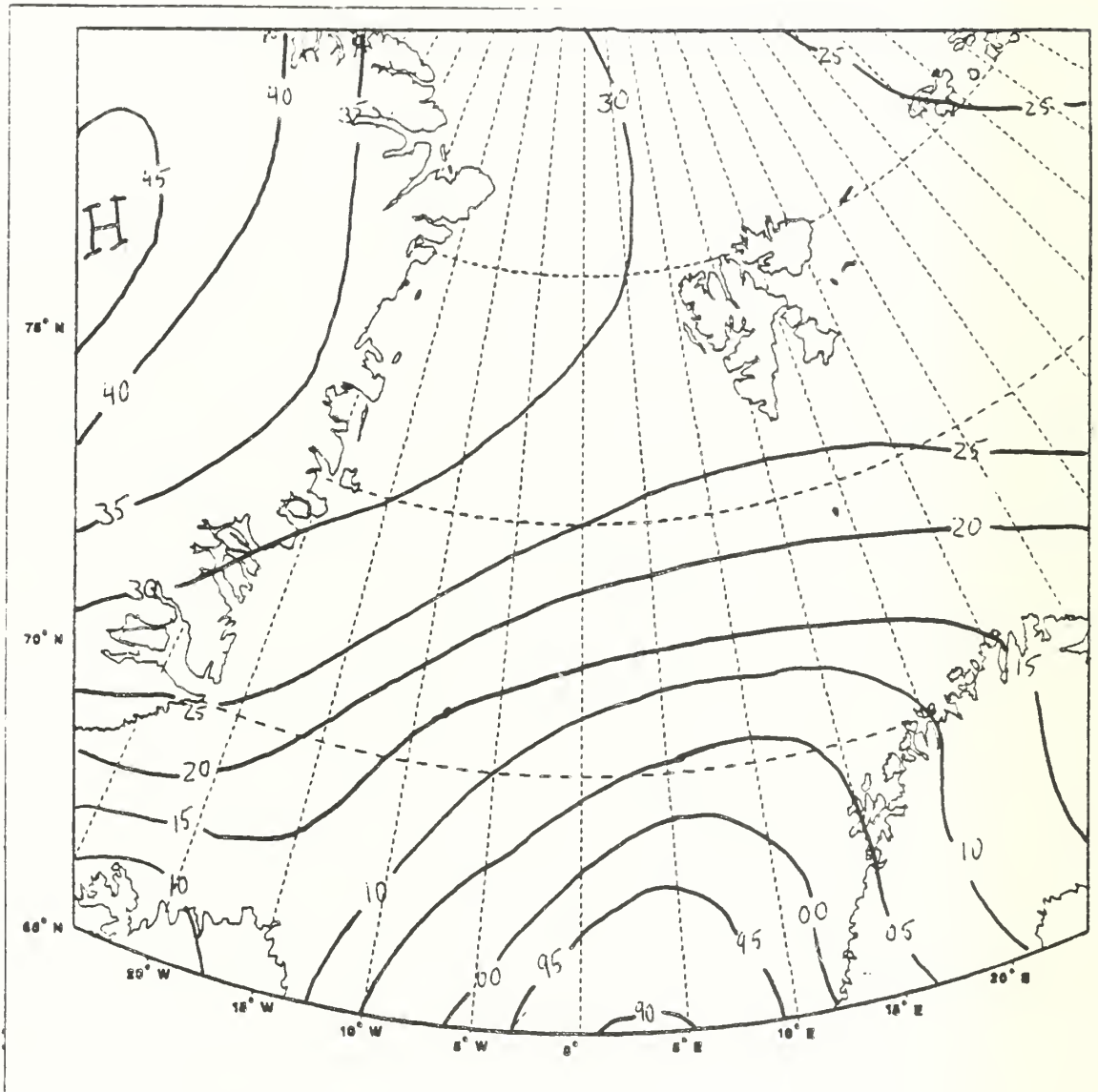




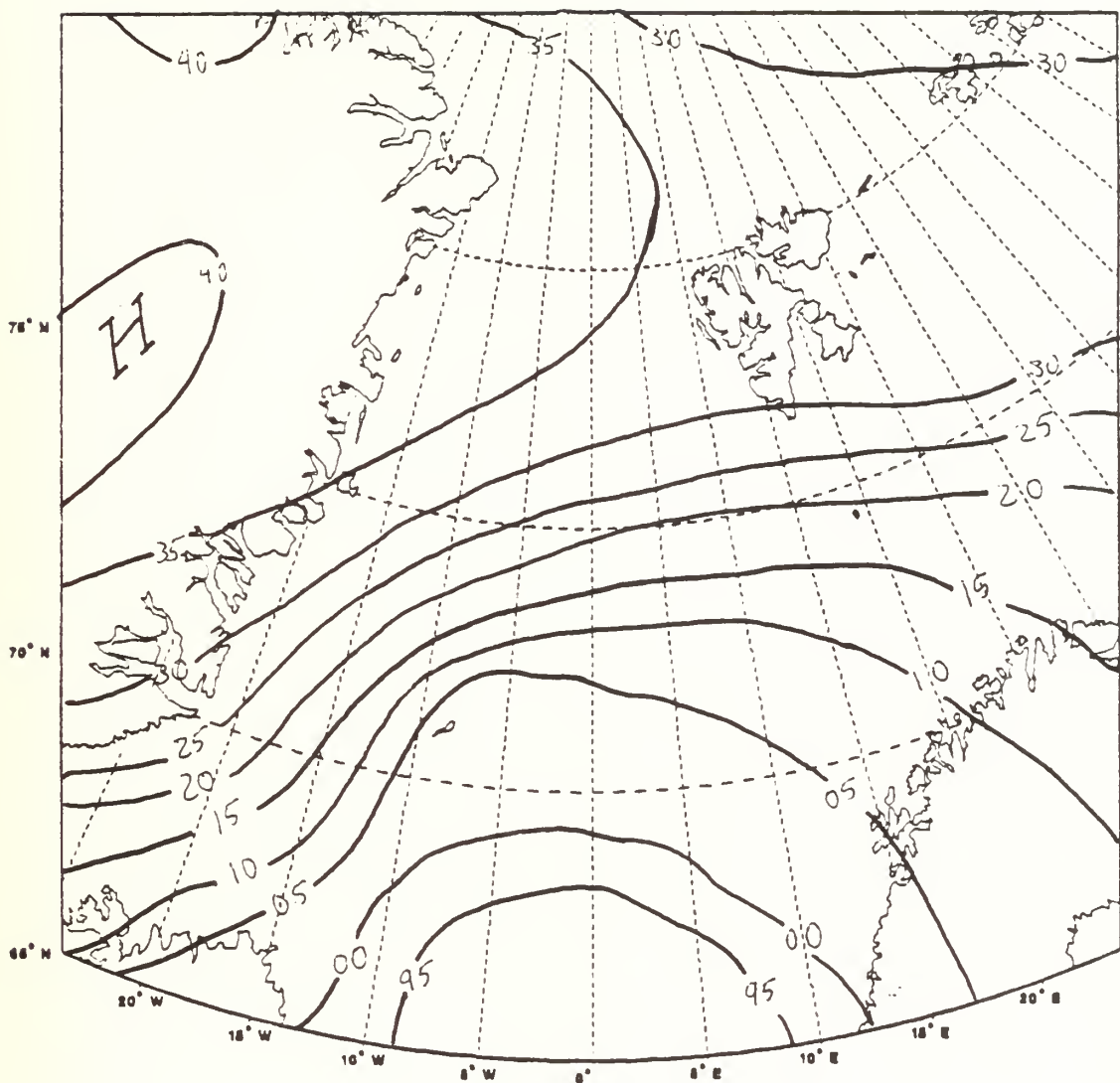


MIZEX 19 MARCH 1987

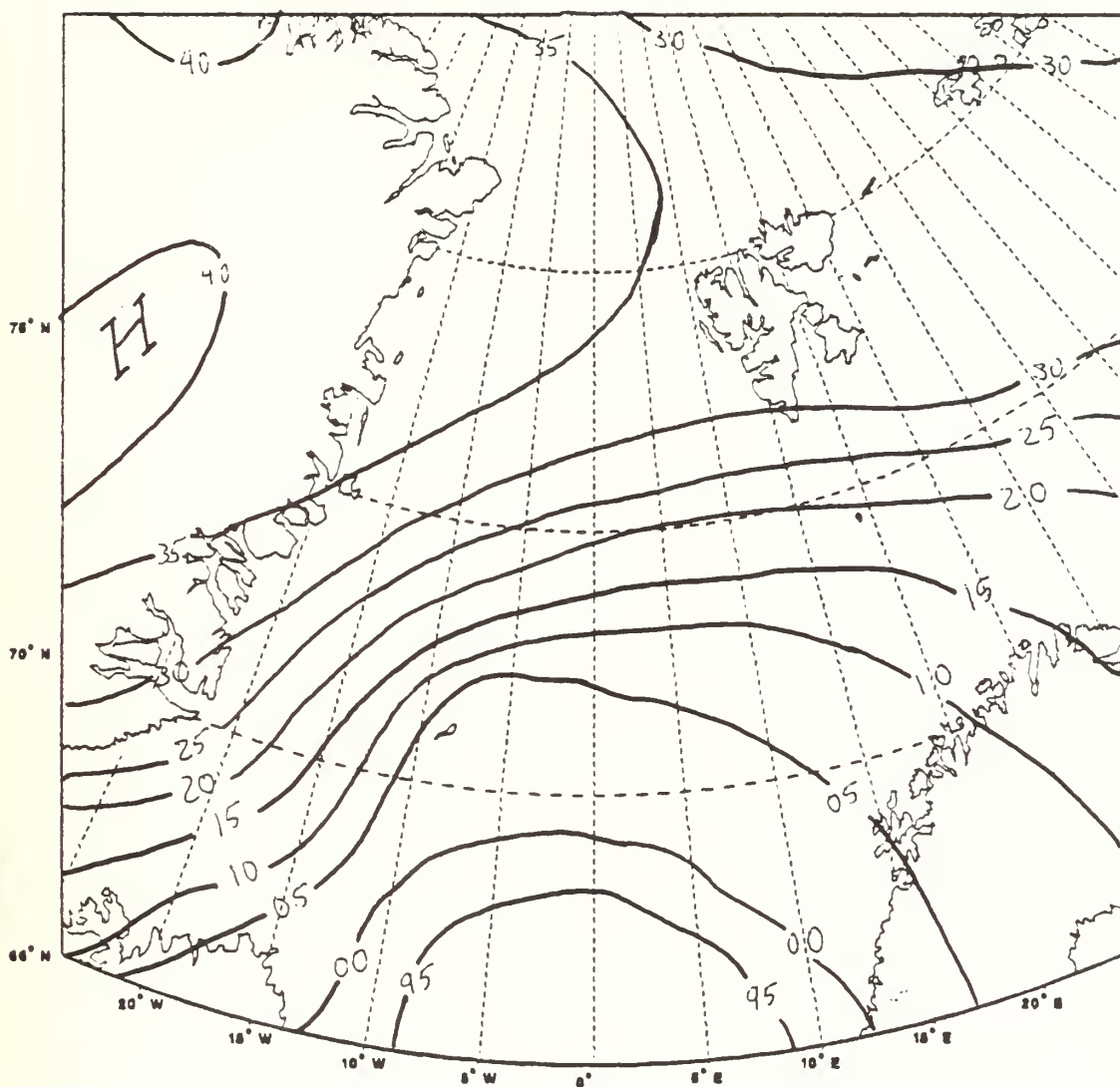




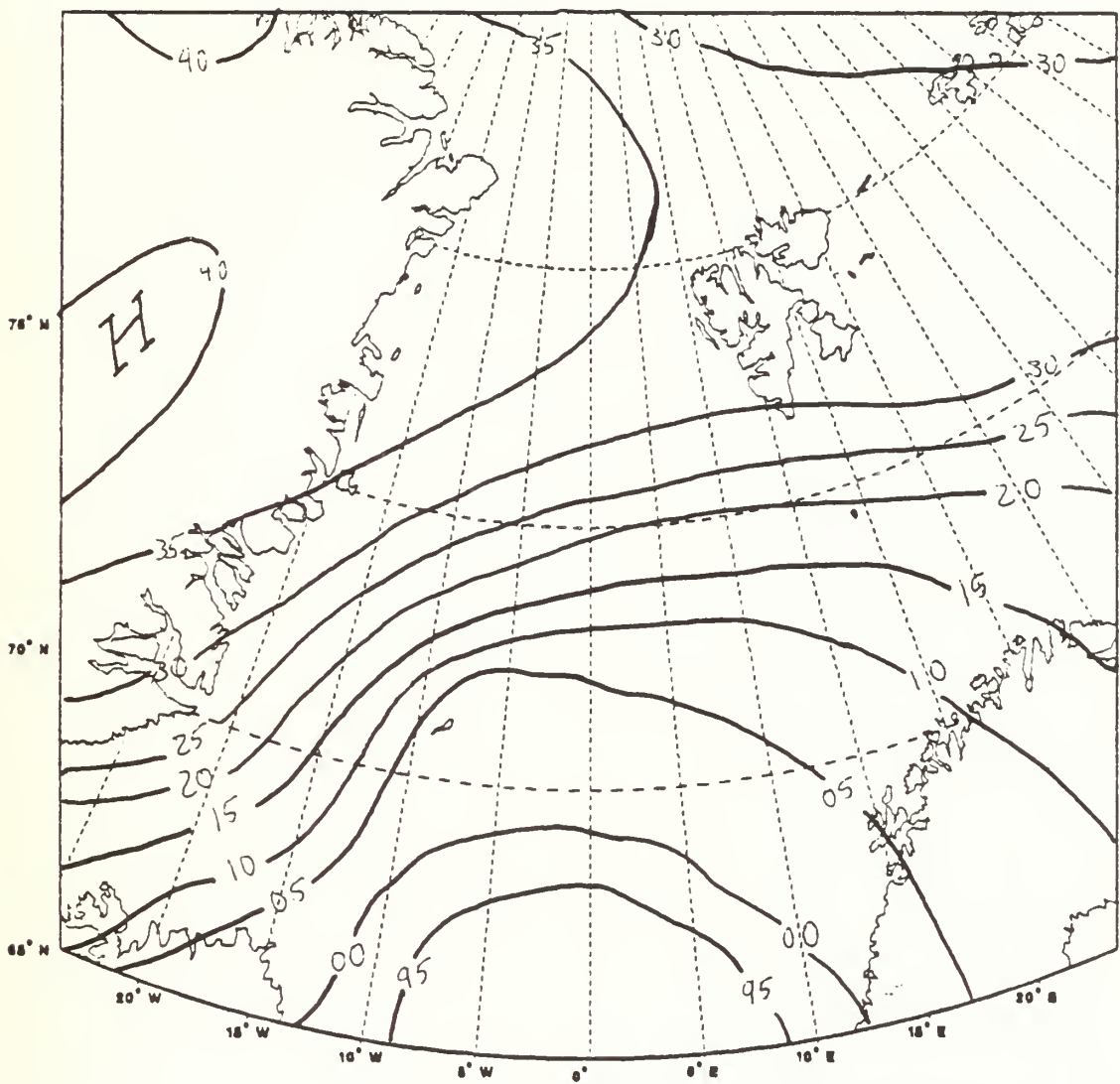
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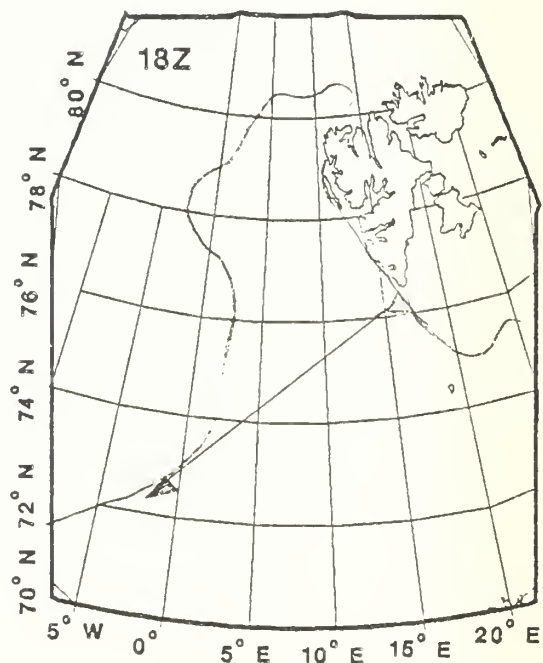
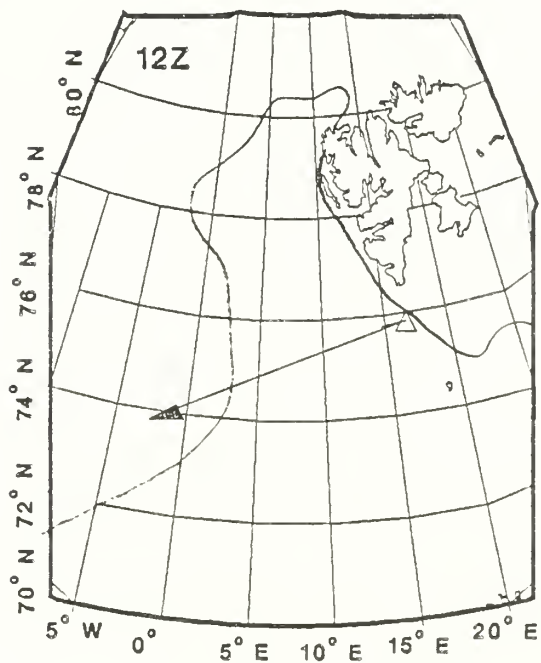
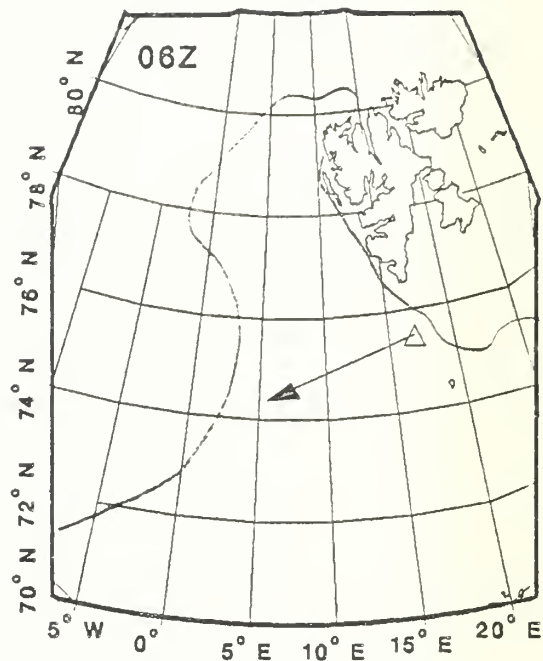
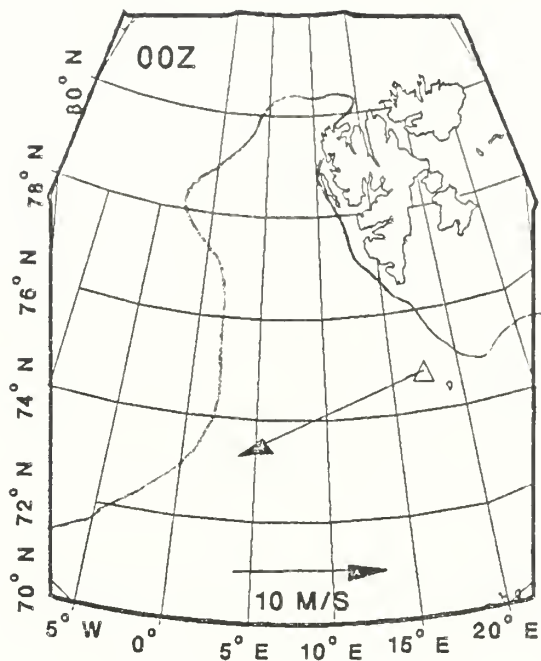
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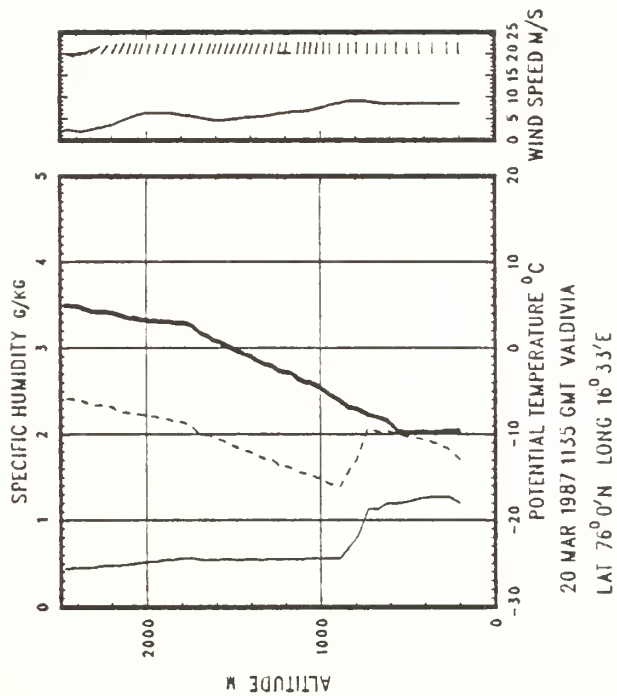
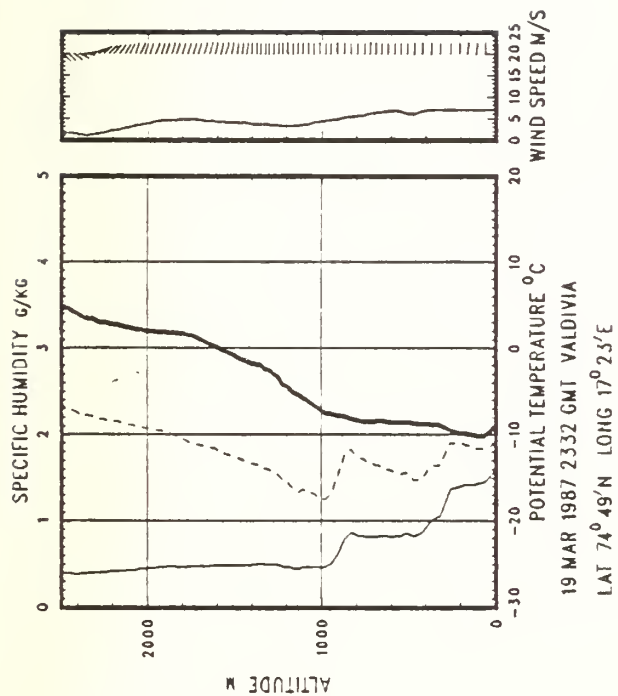
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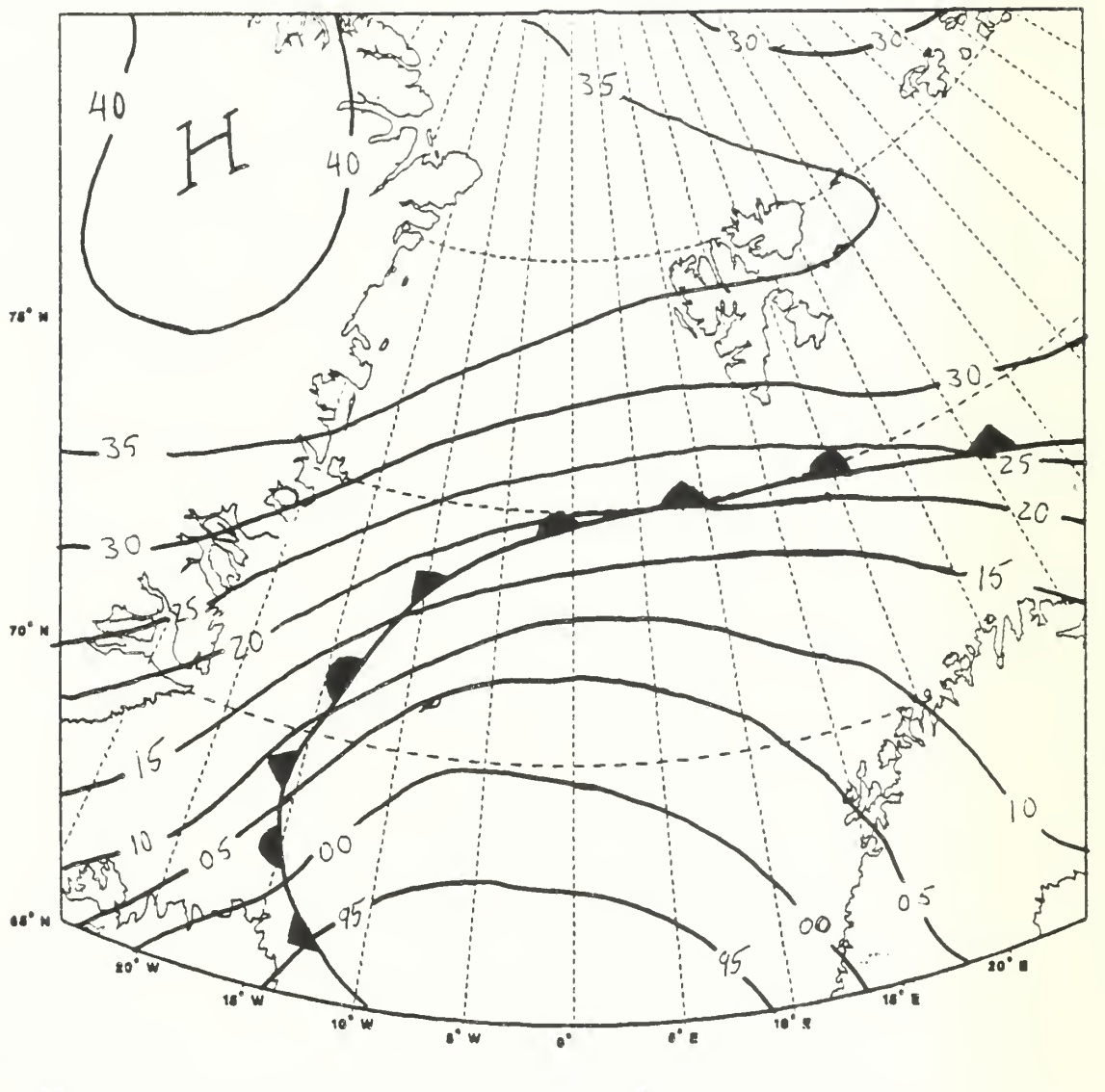


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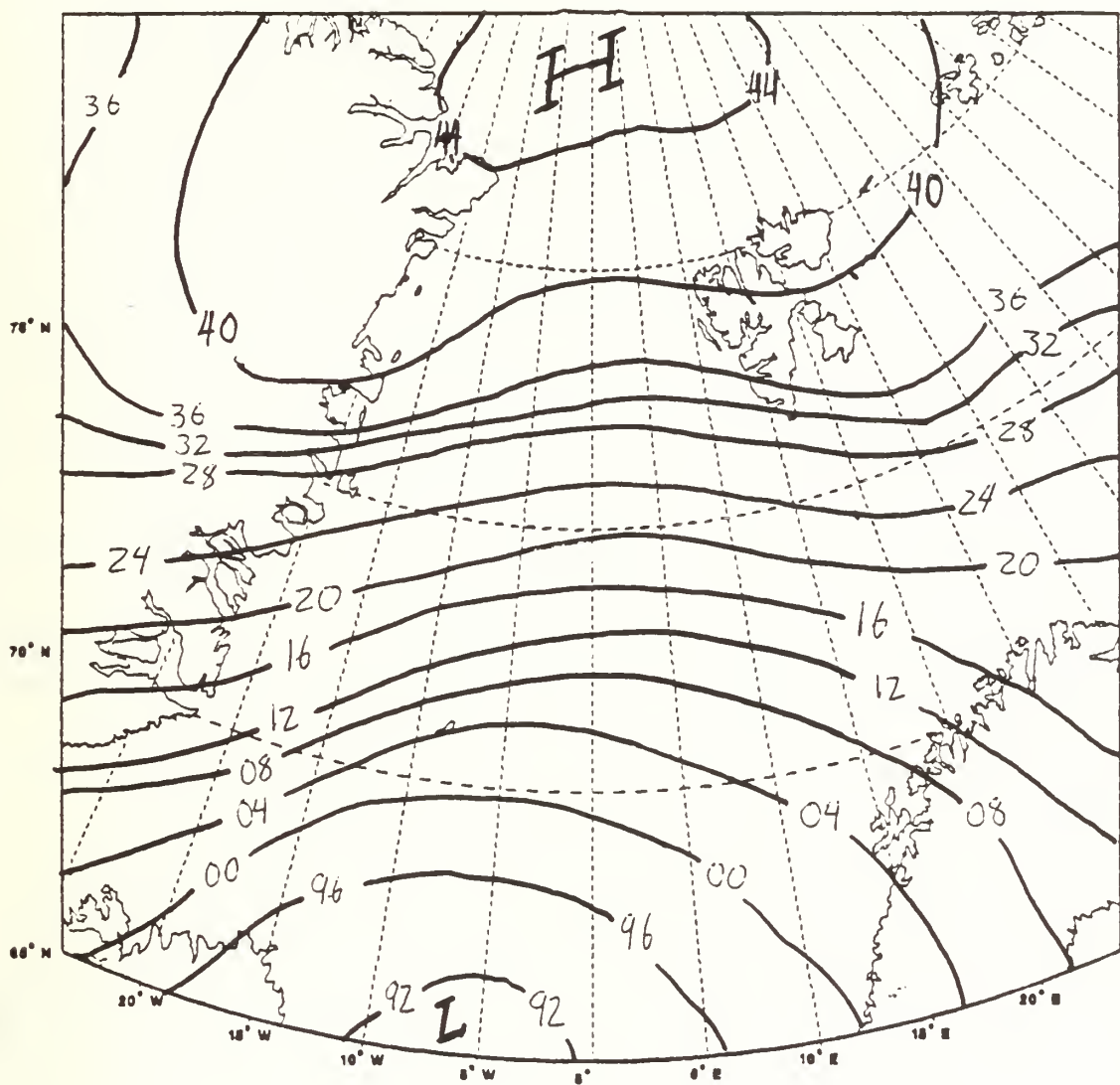


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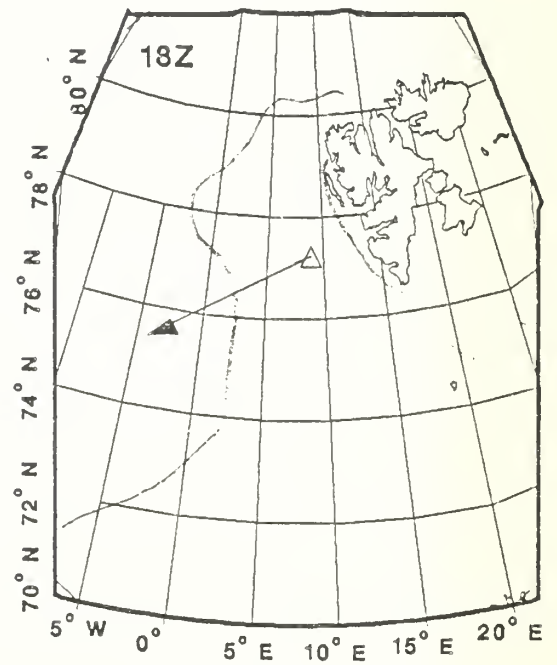
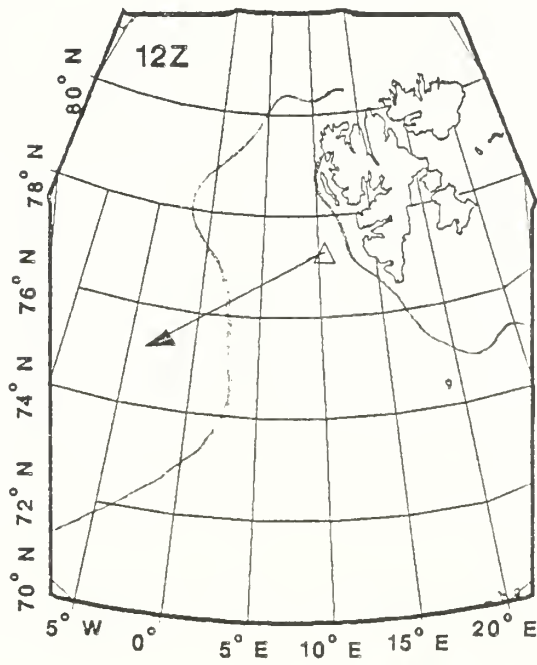
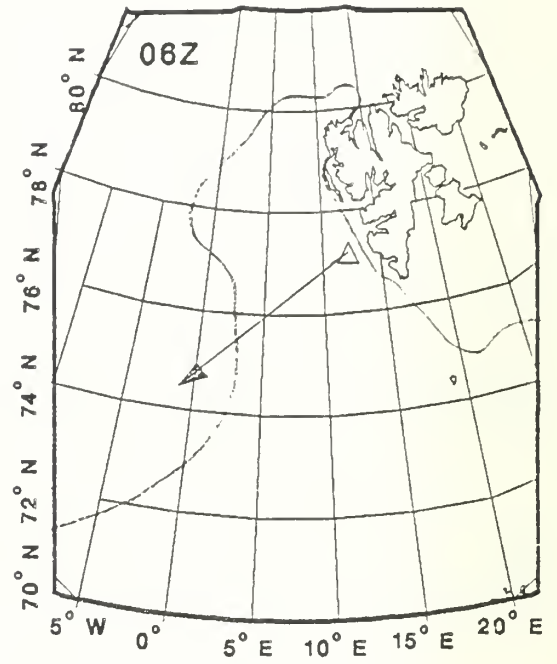
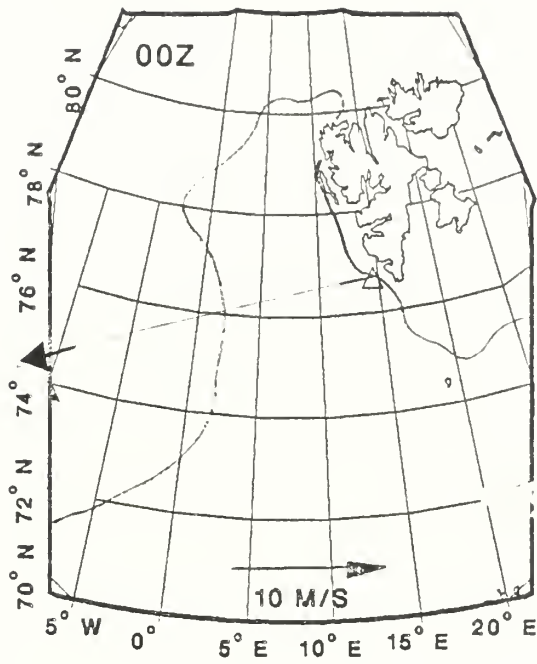




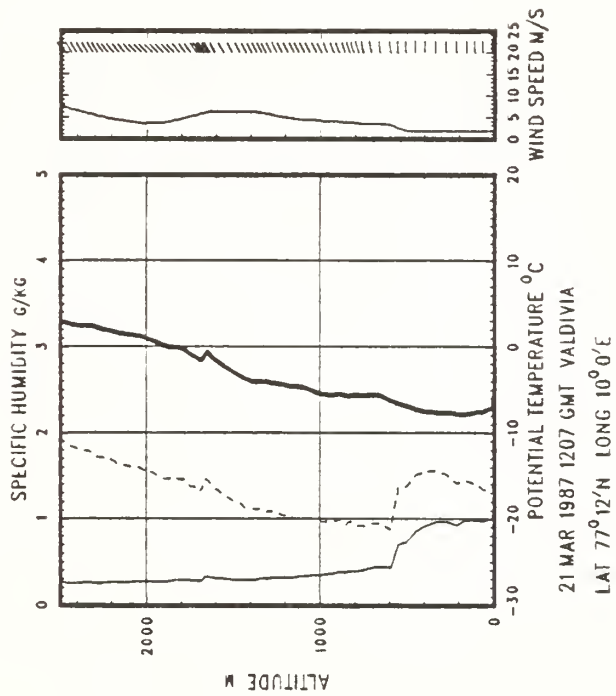
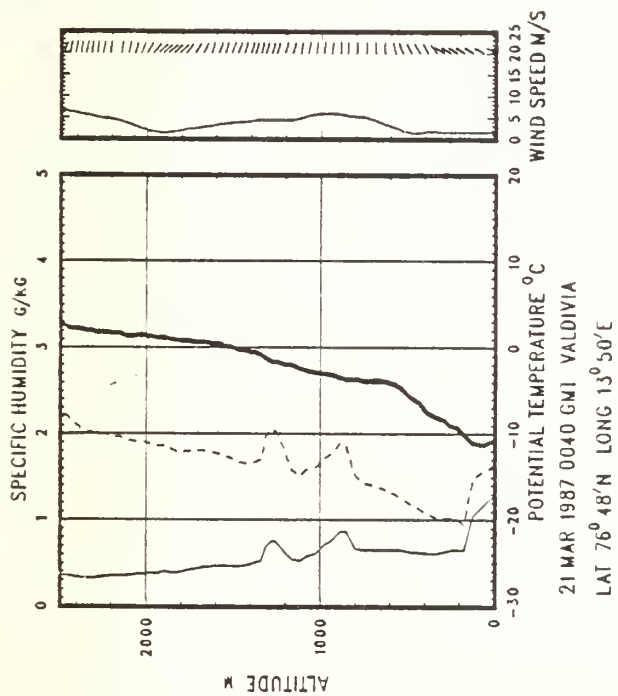
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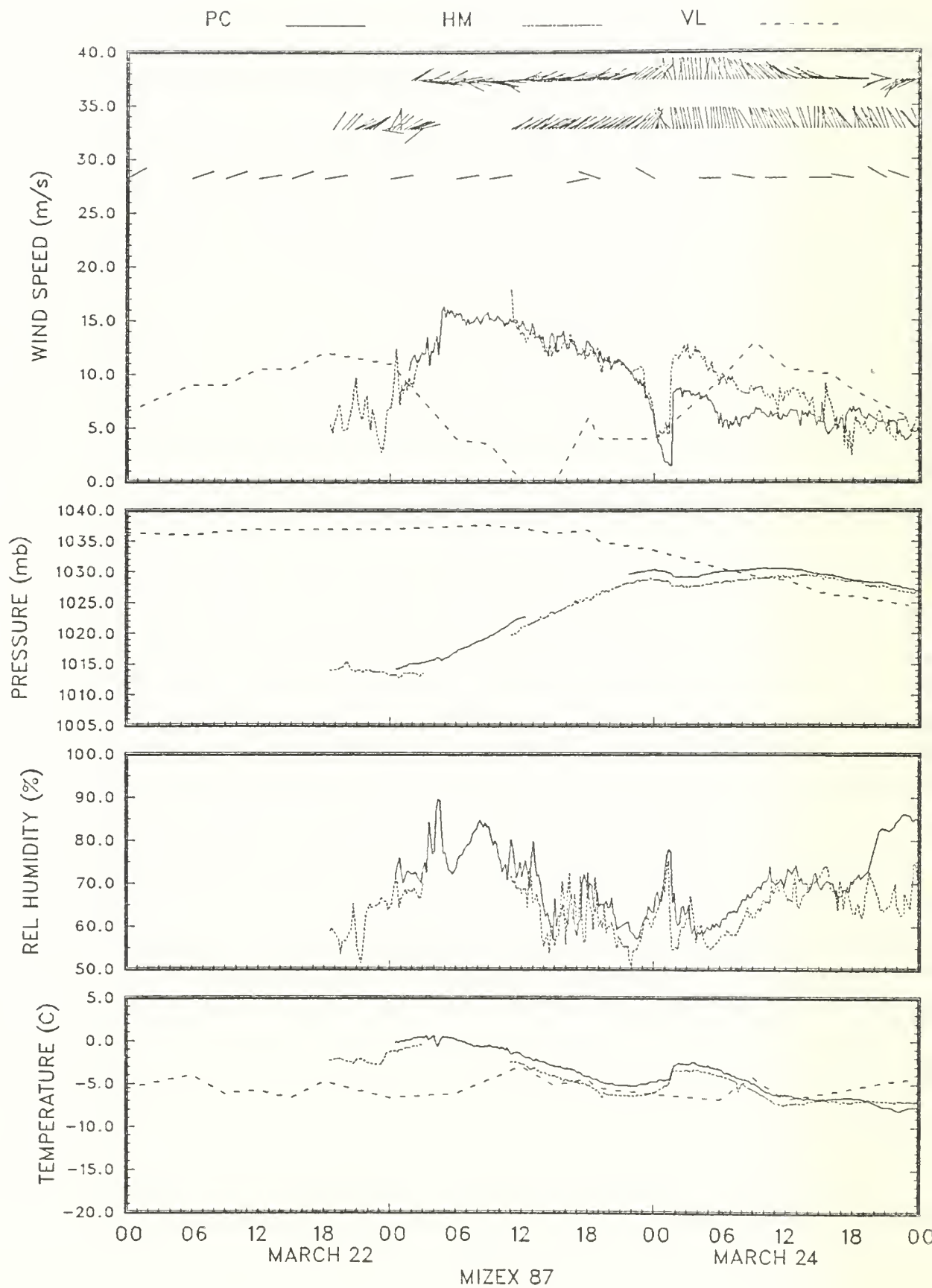


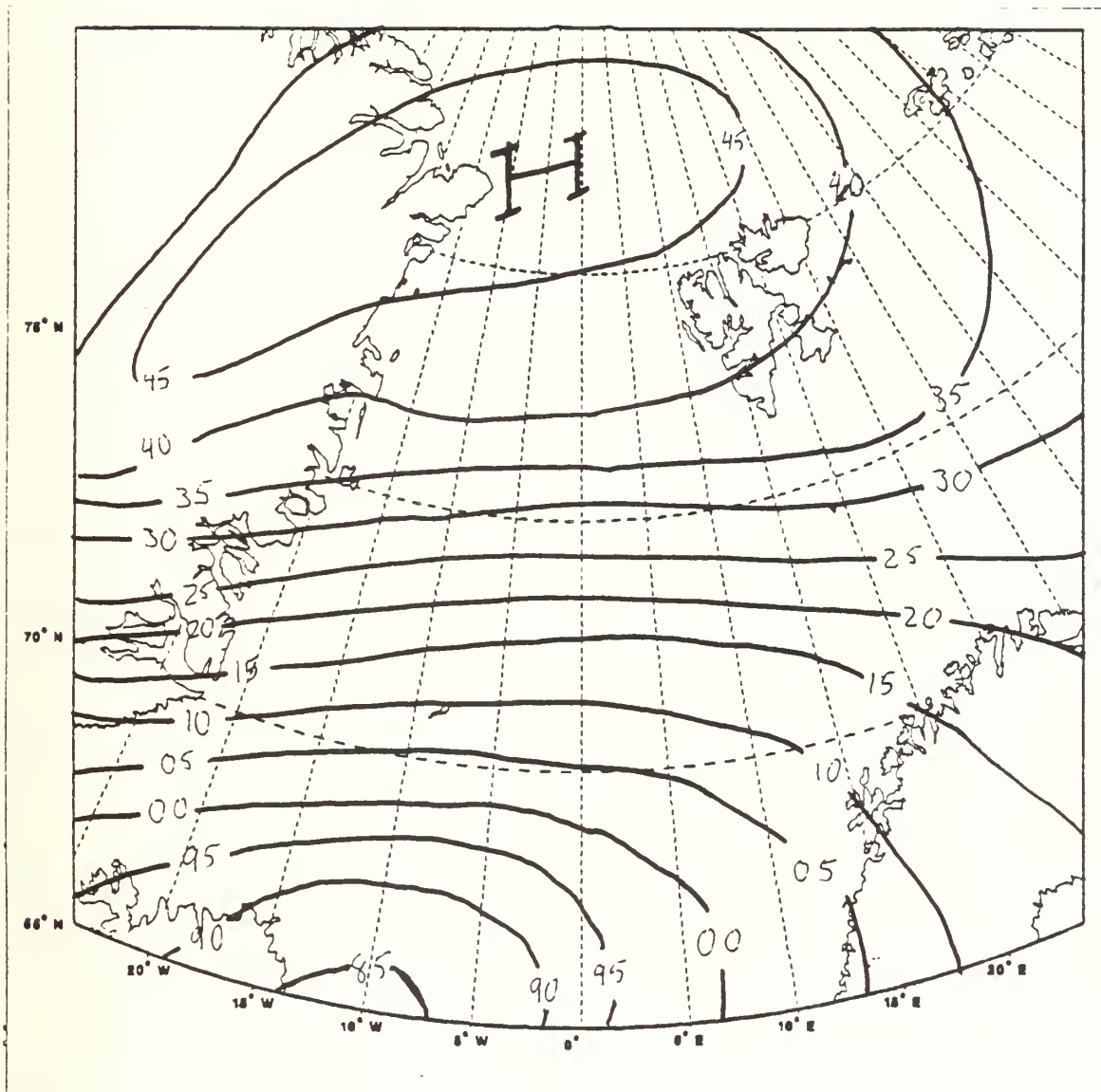
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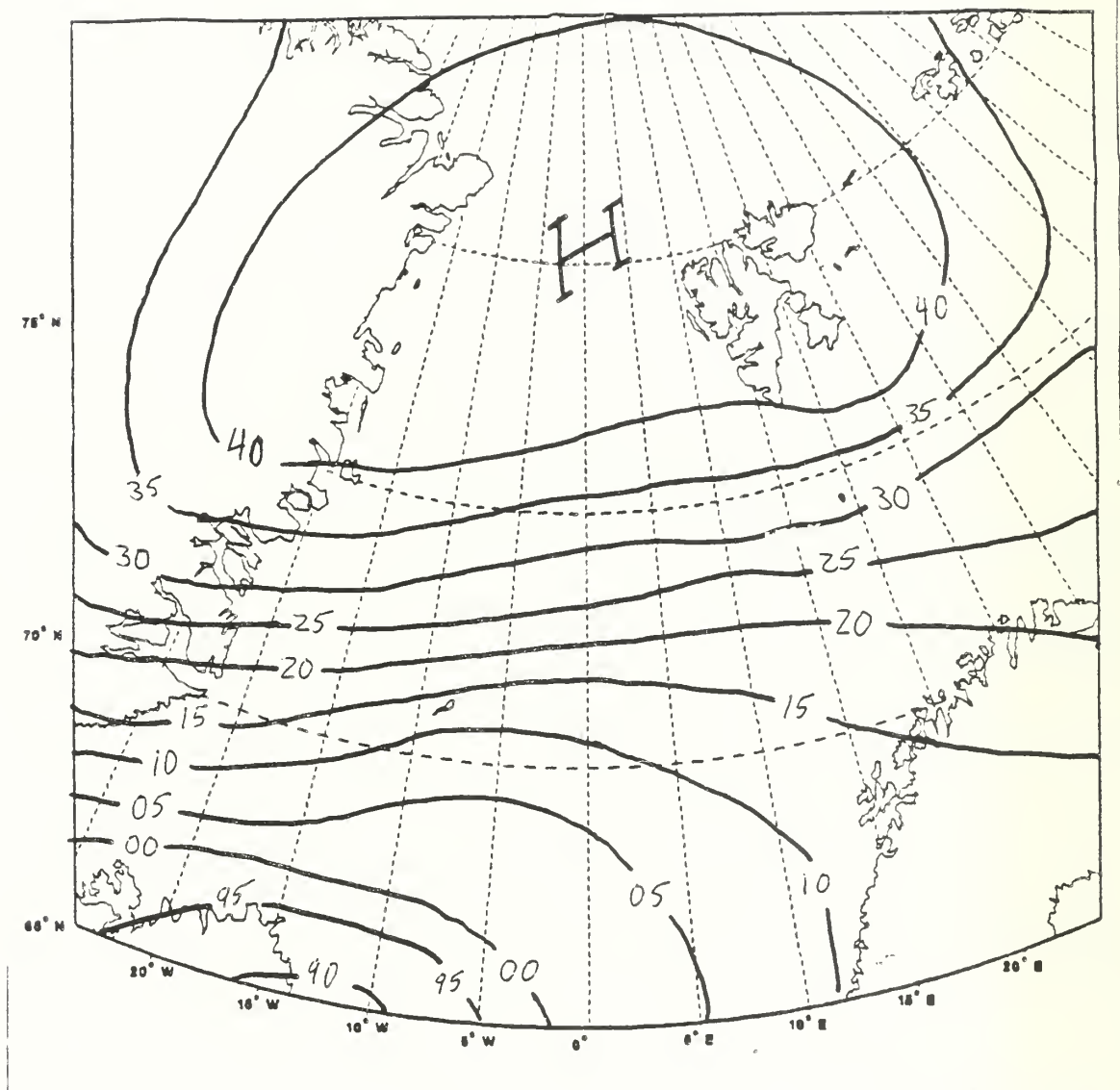
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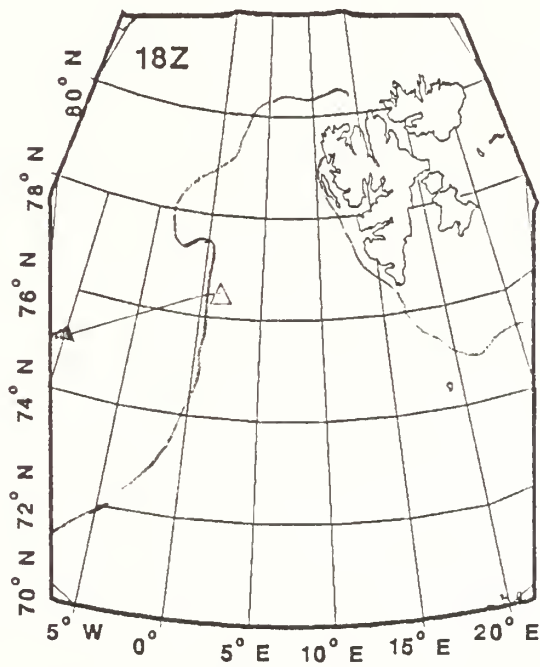
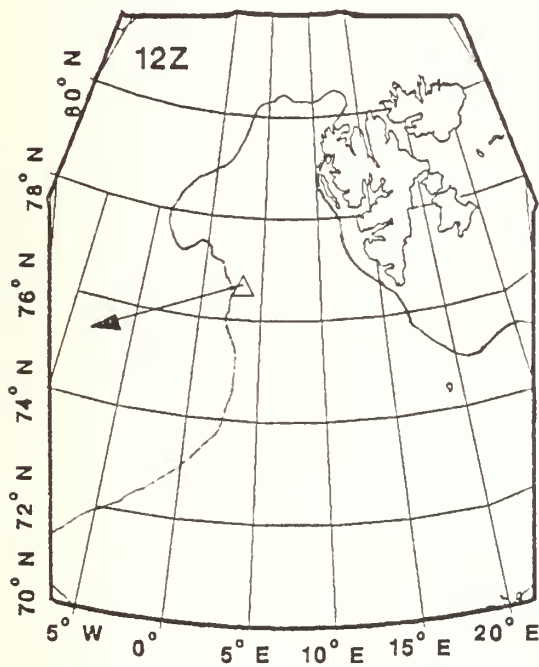
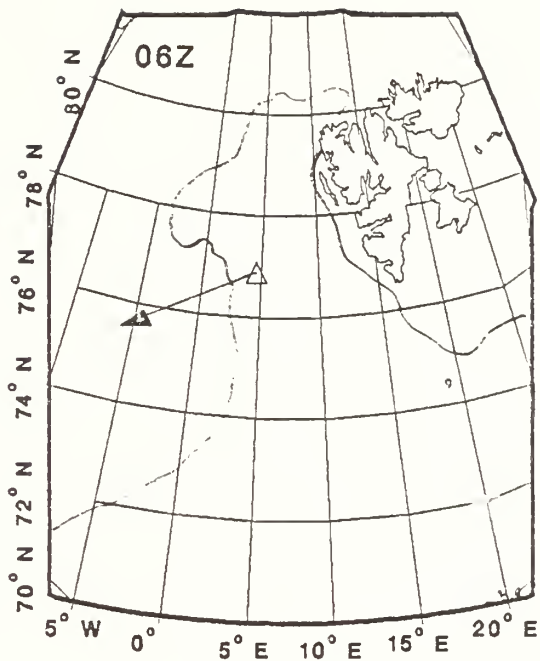
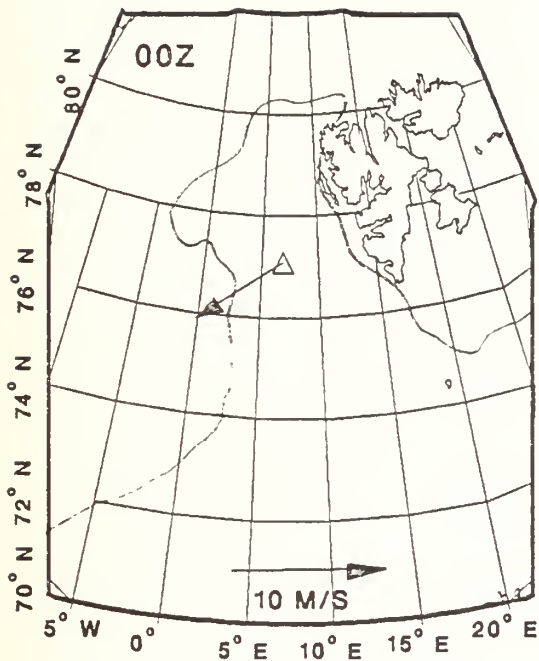




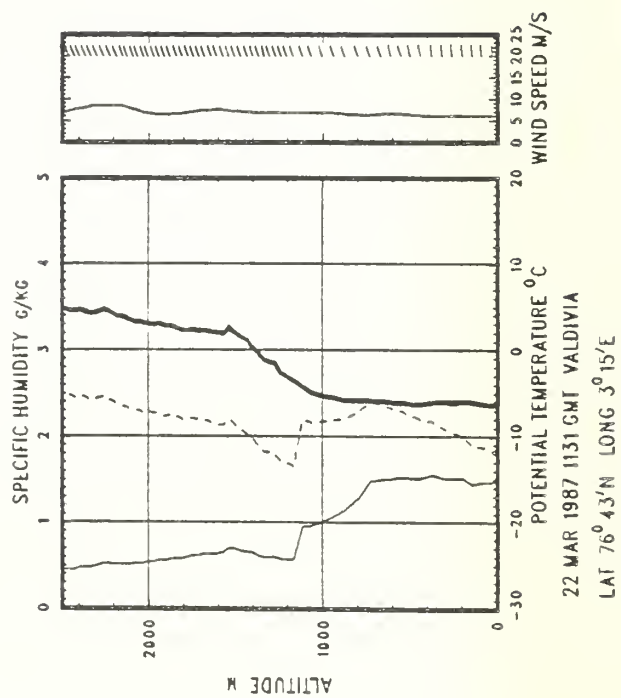
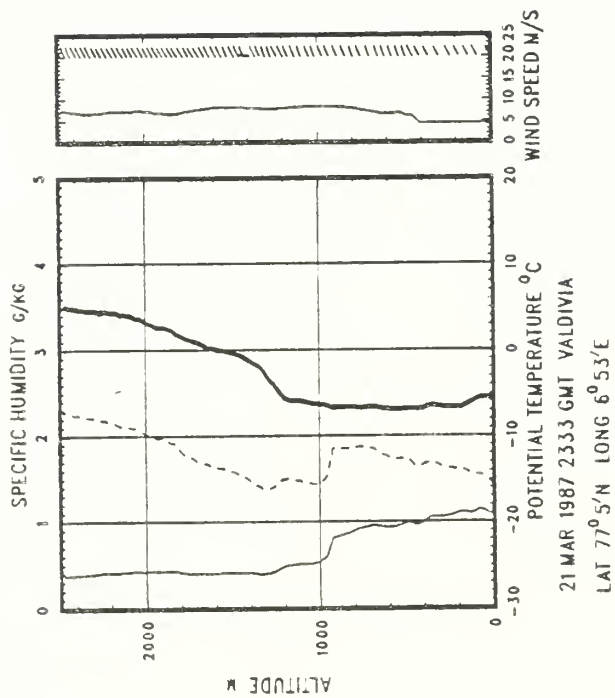
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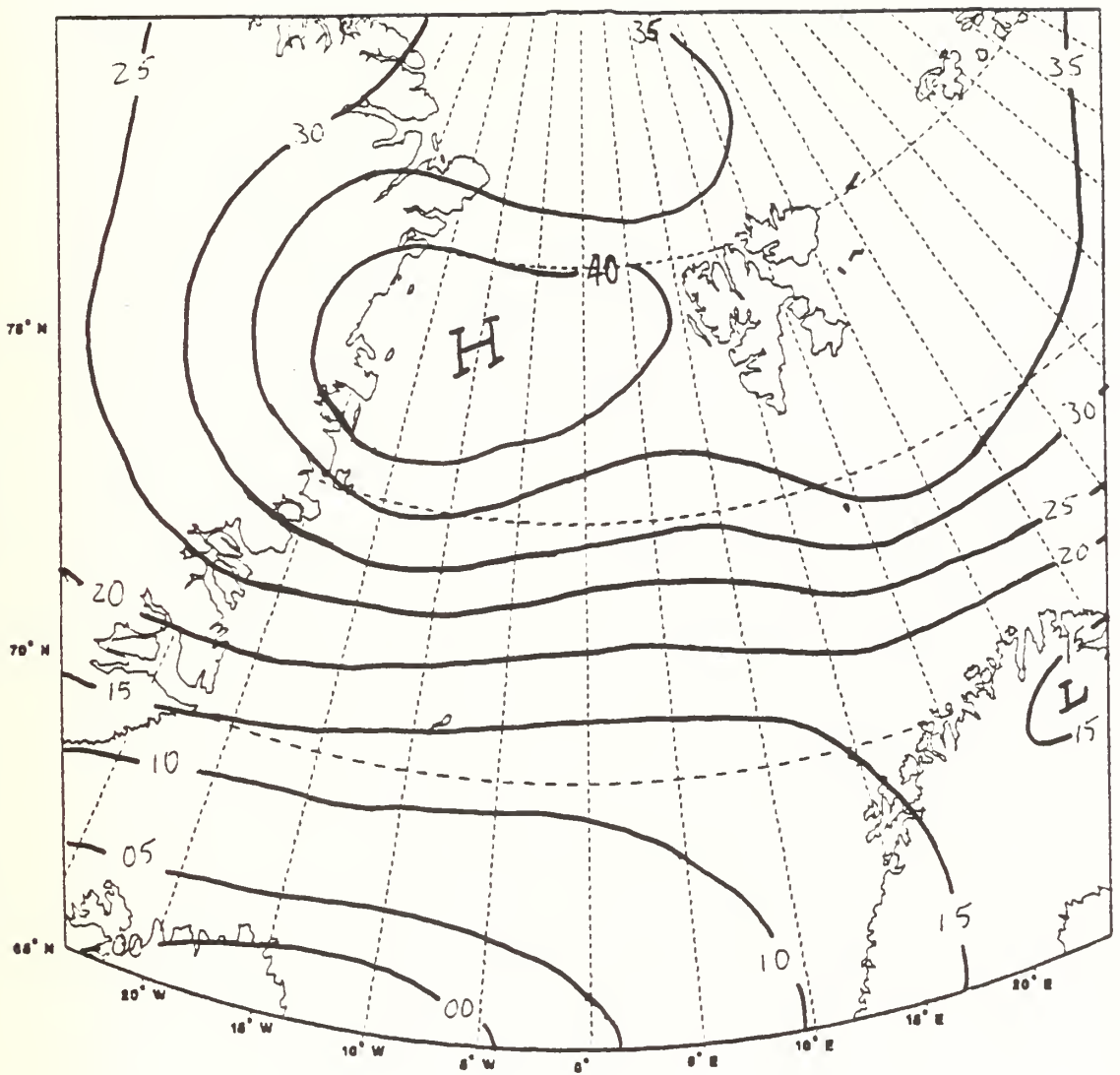


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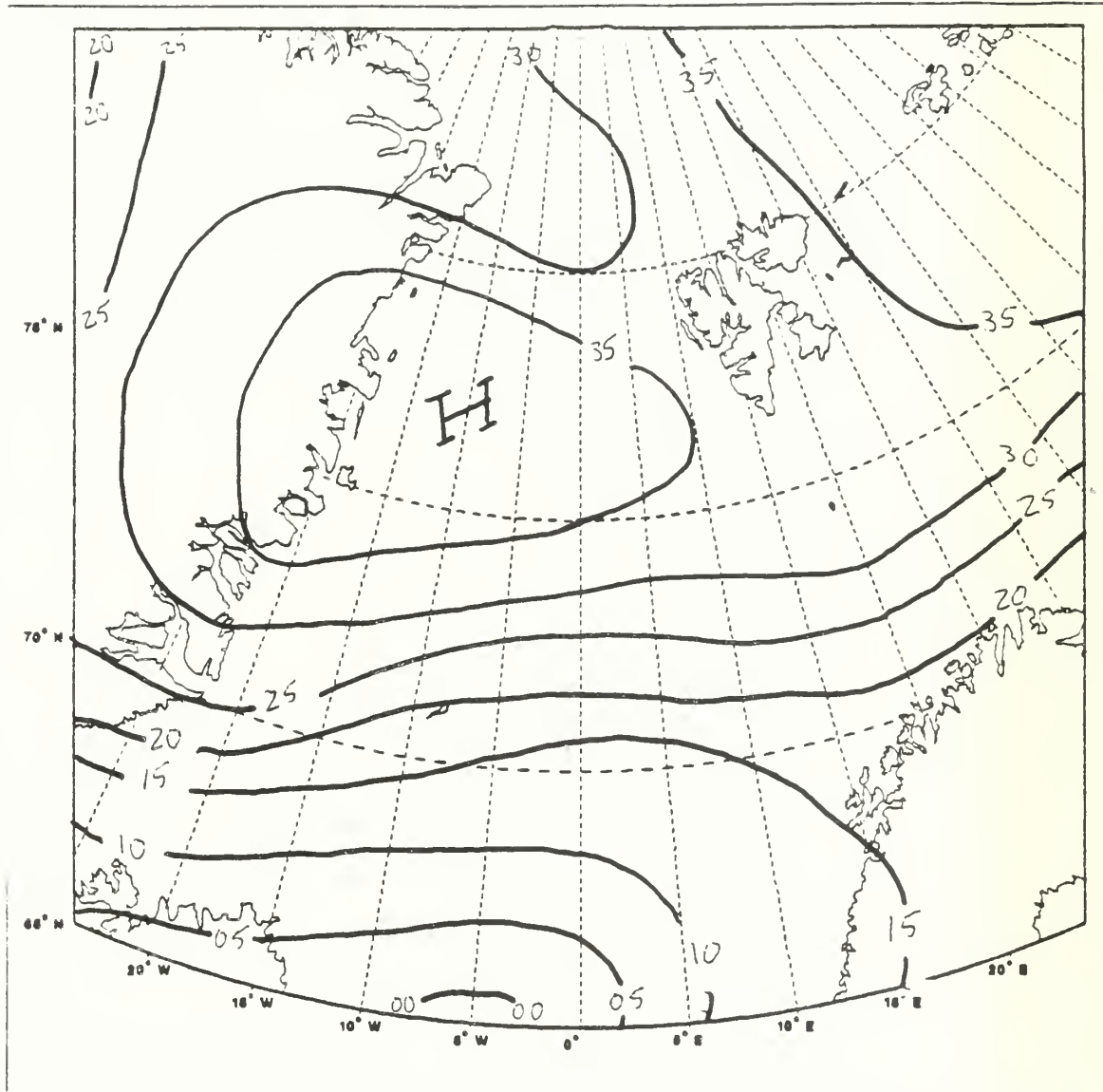


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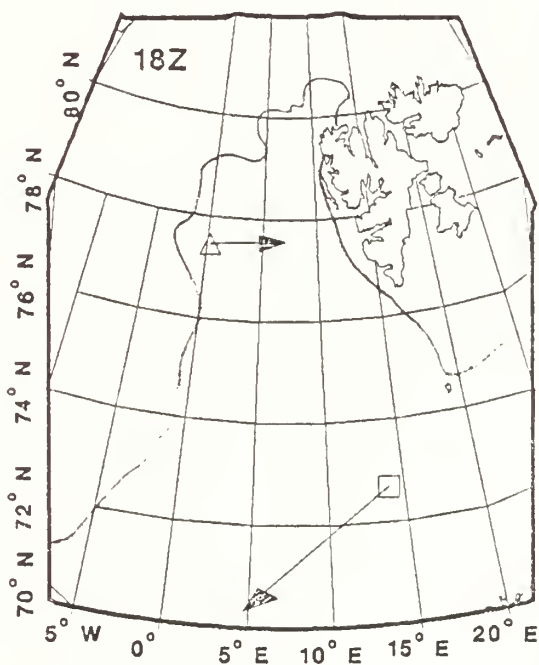
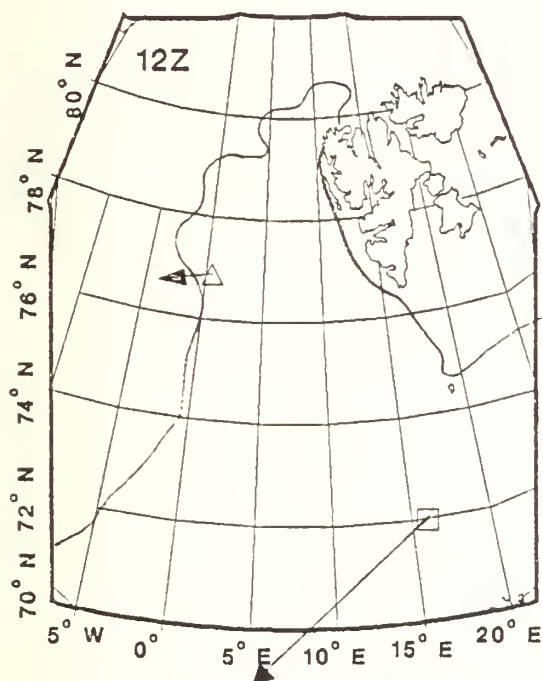
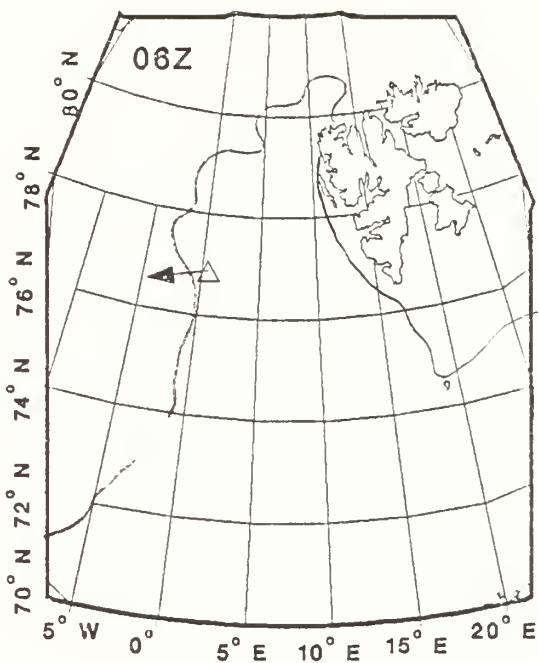
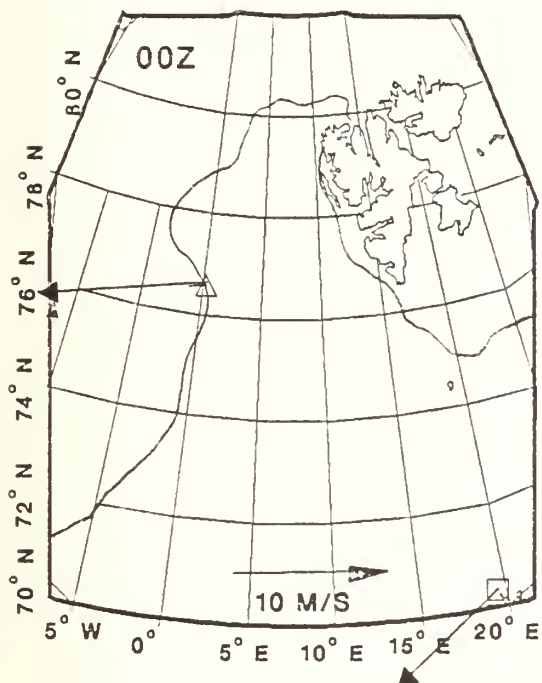




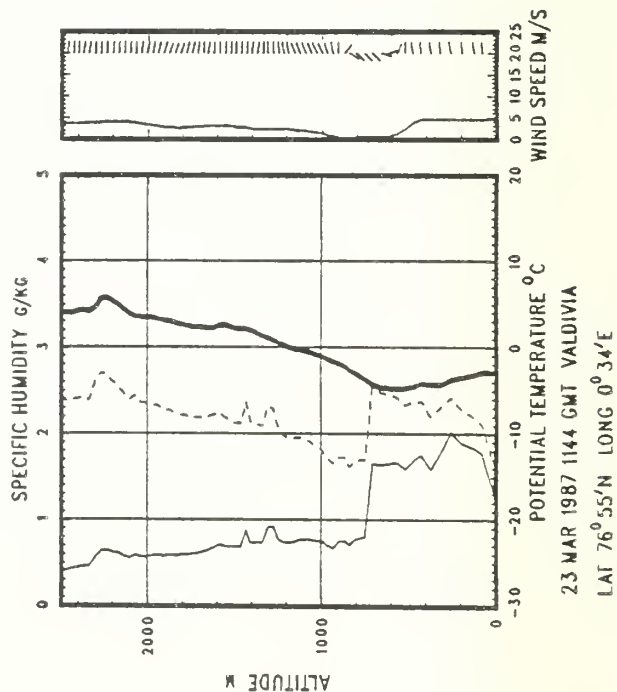
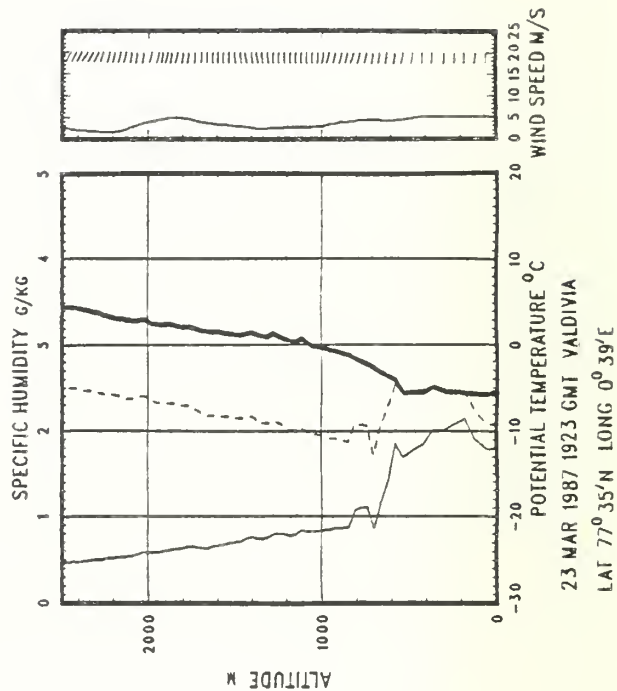
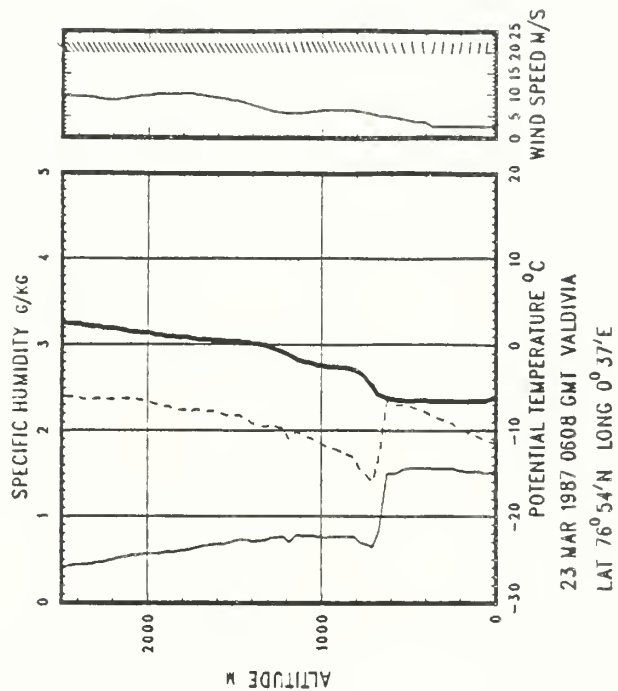
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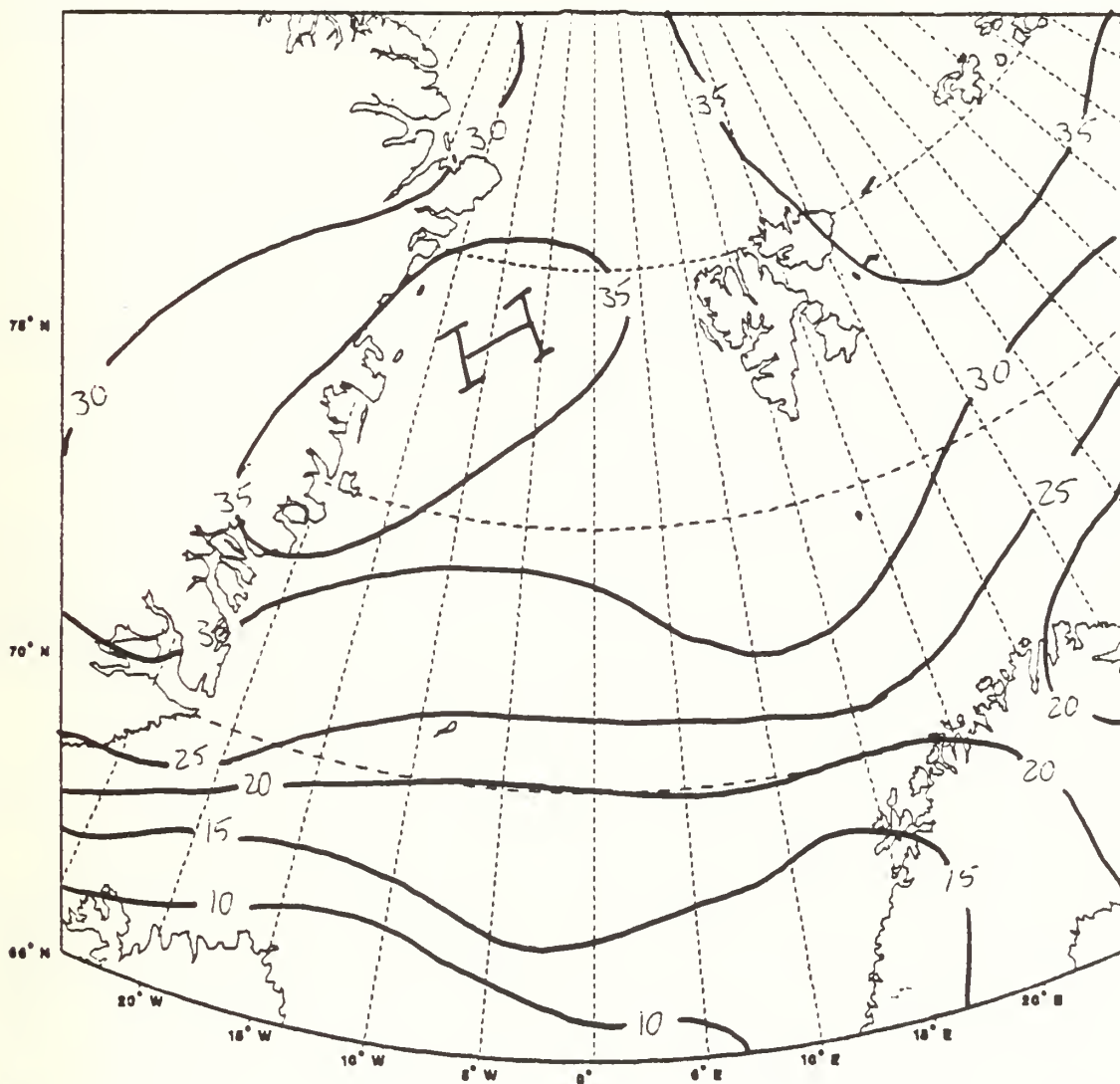


1500 UT 23 March 1987 (1200 UT missing)

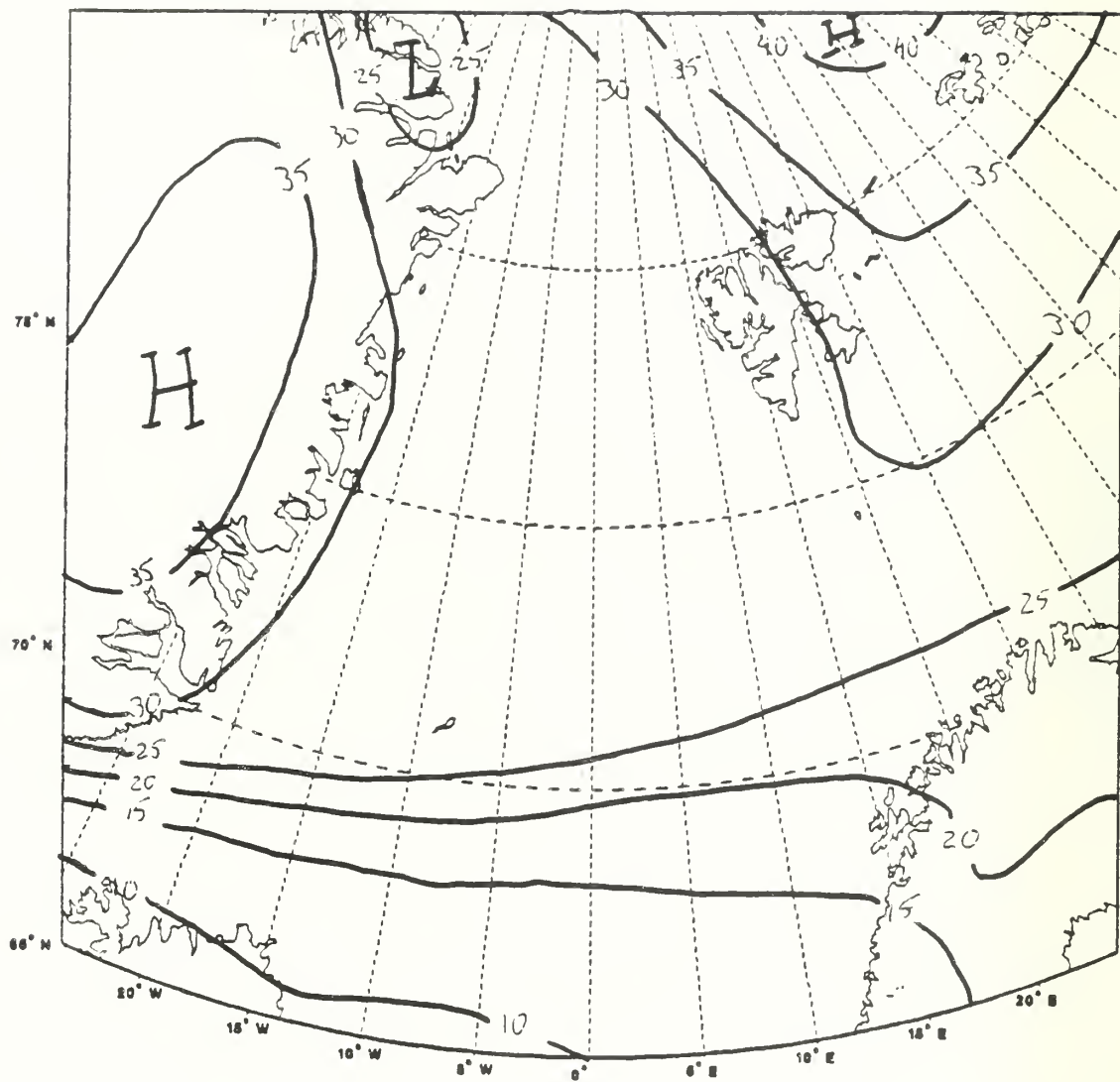


MIZEX 23 MARCH 1937

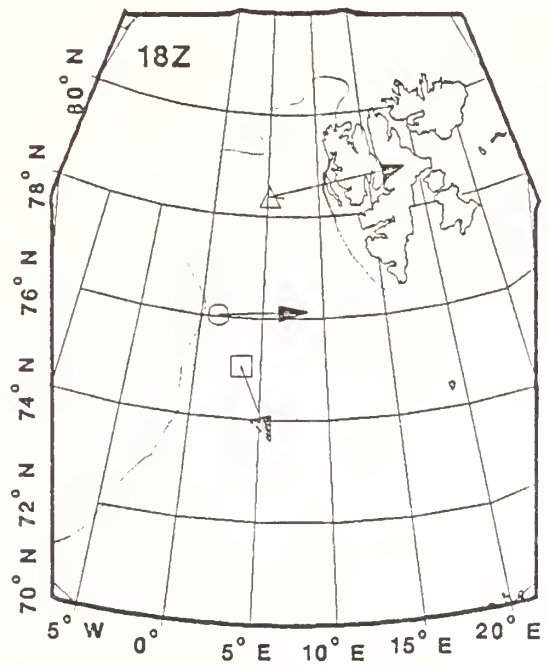
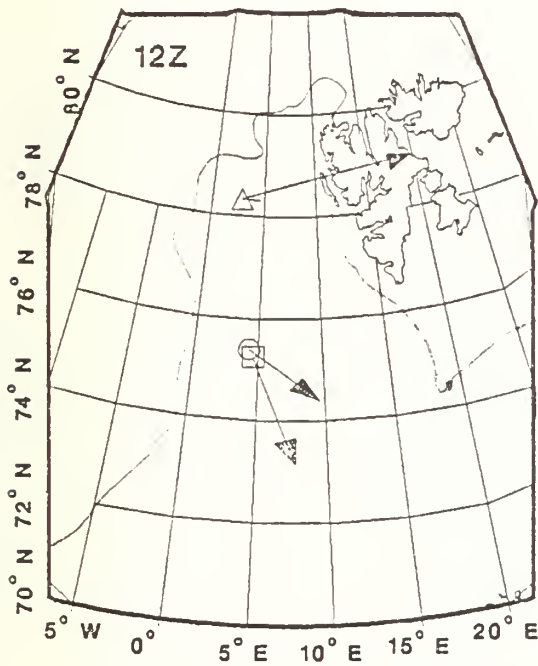
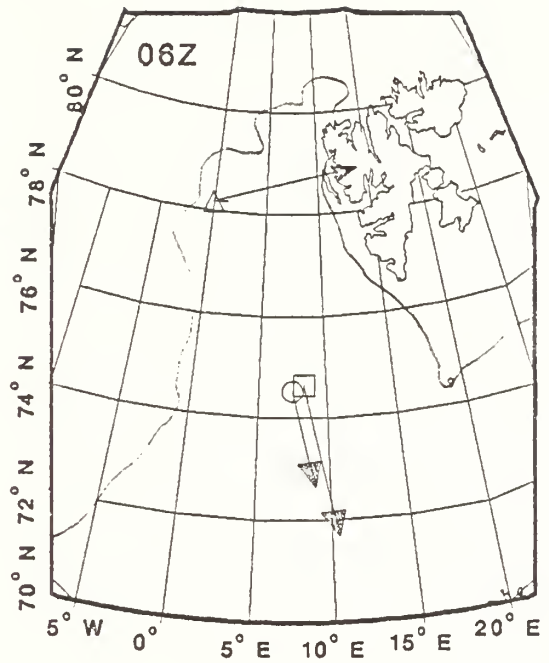
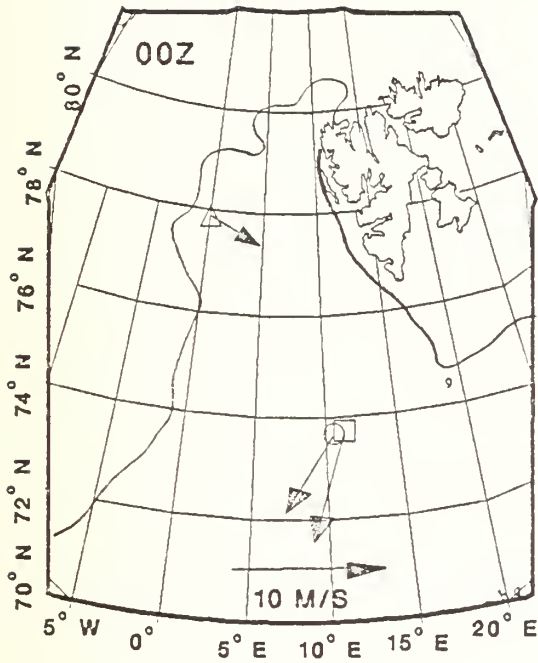




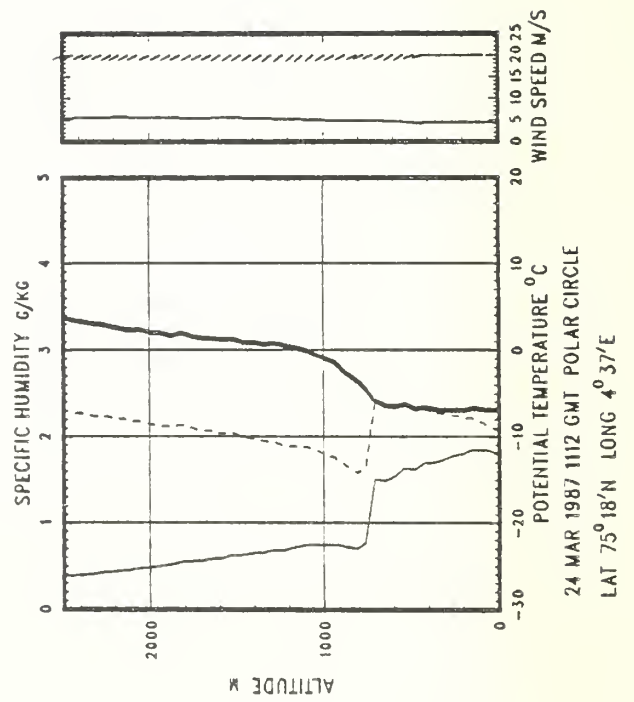
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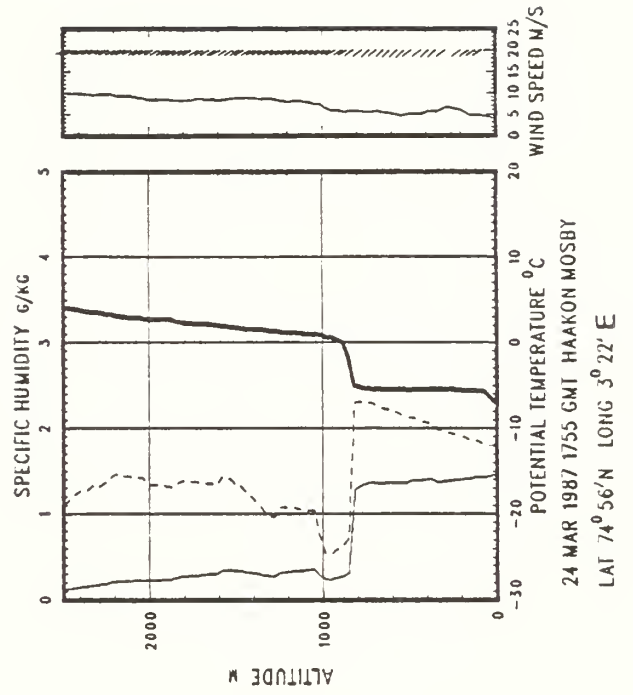
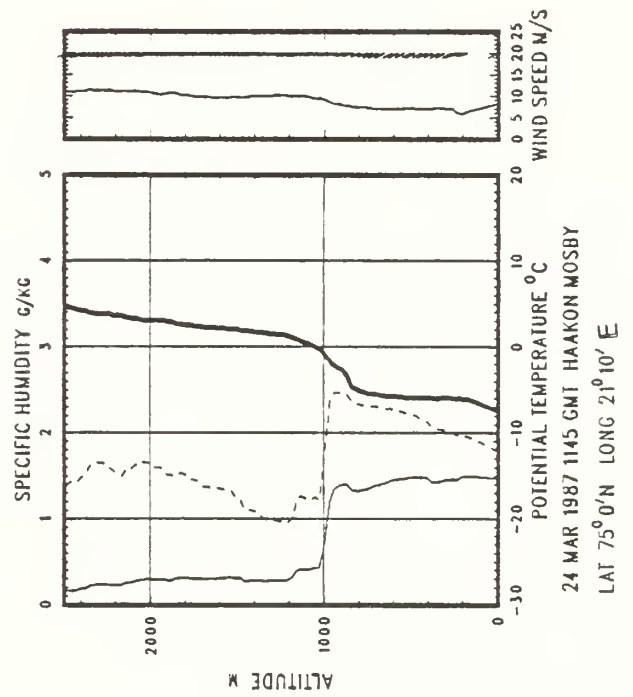


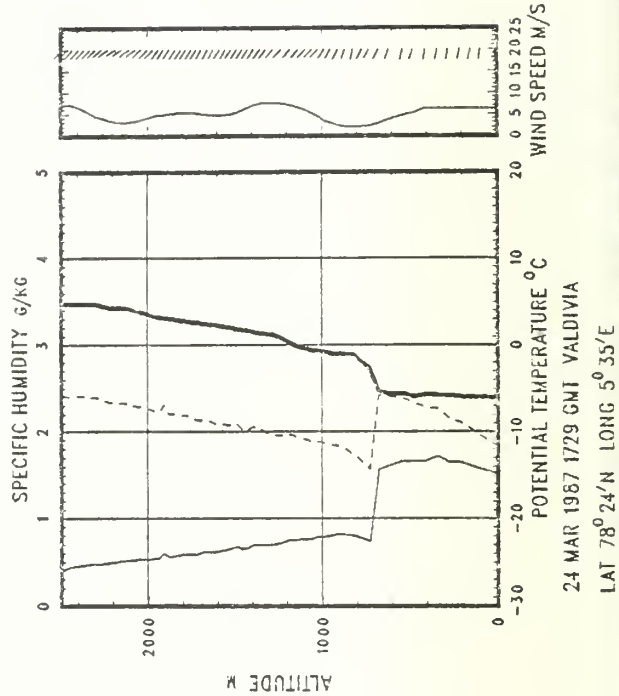
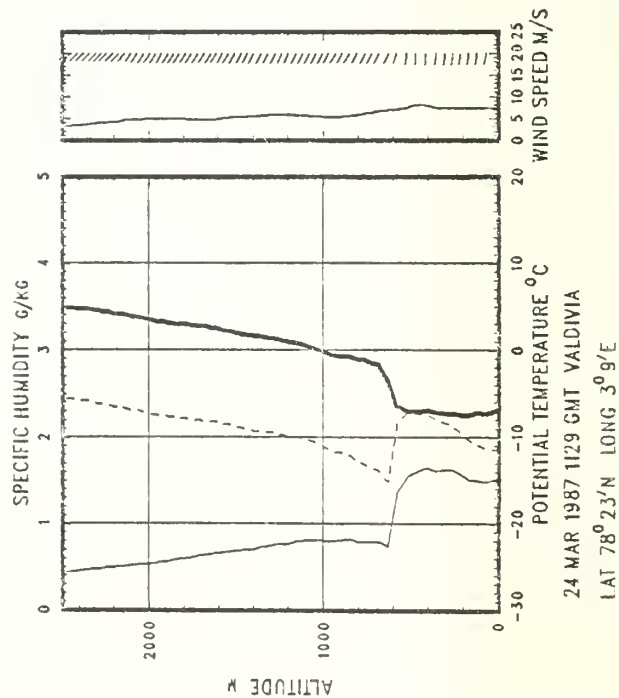
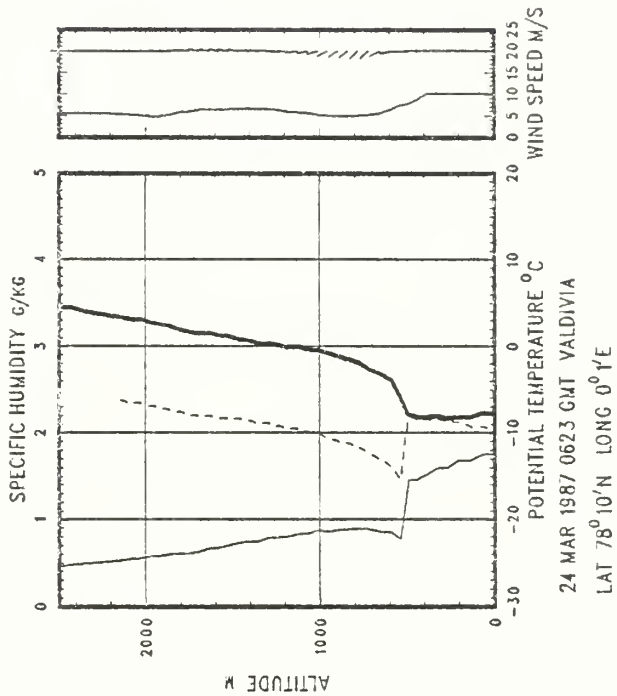
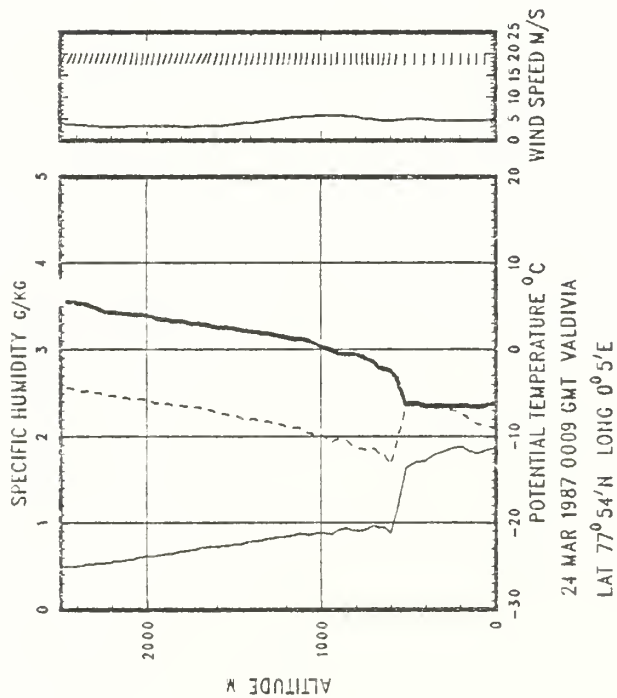
1200 UT 24 March 1987

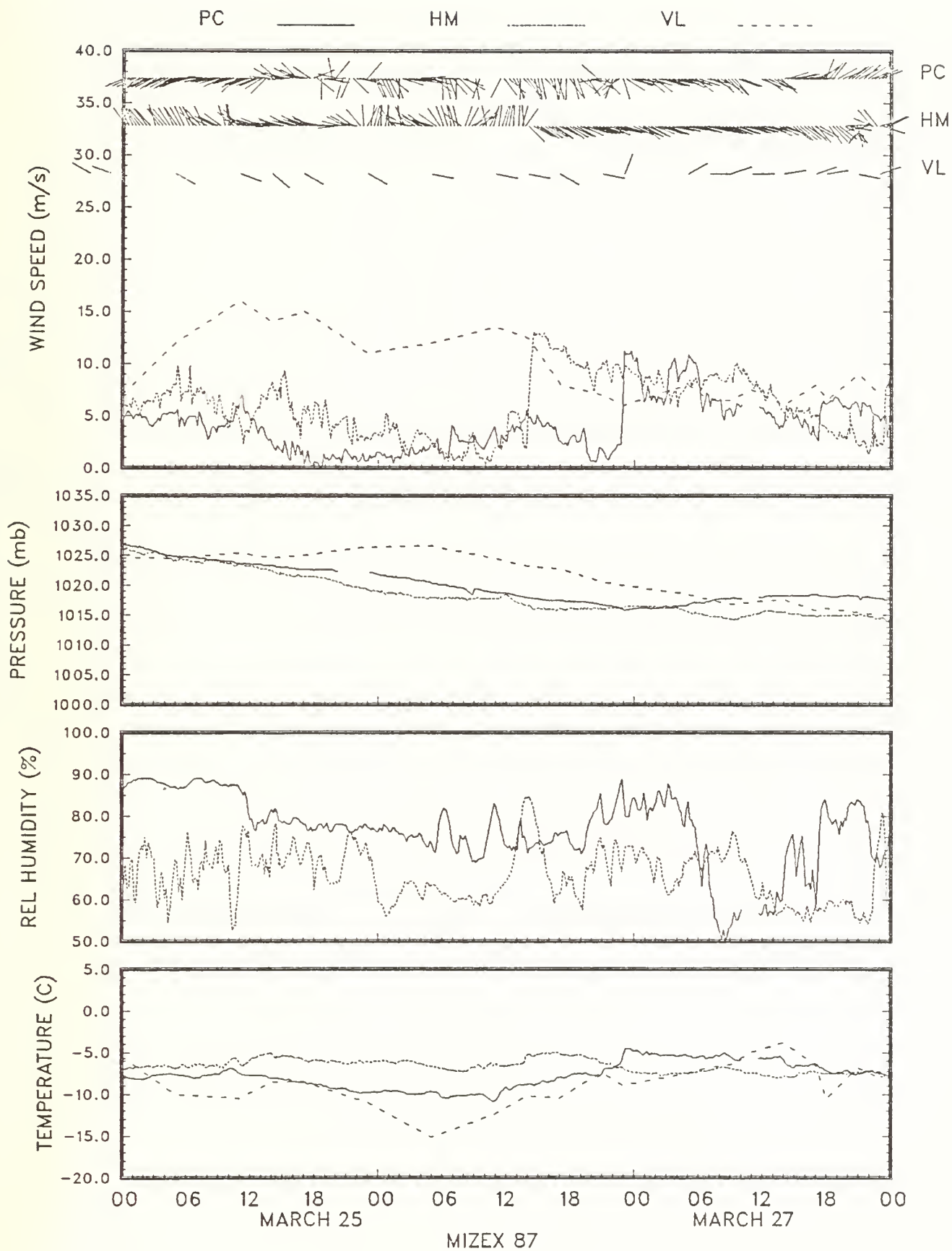


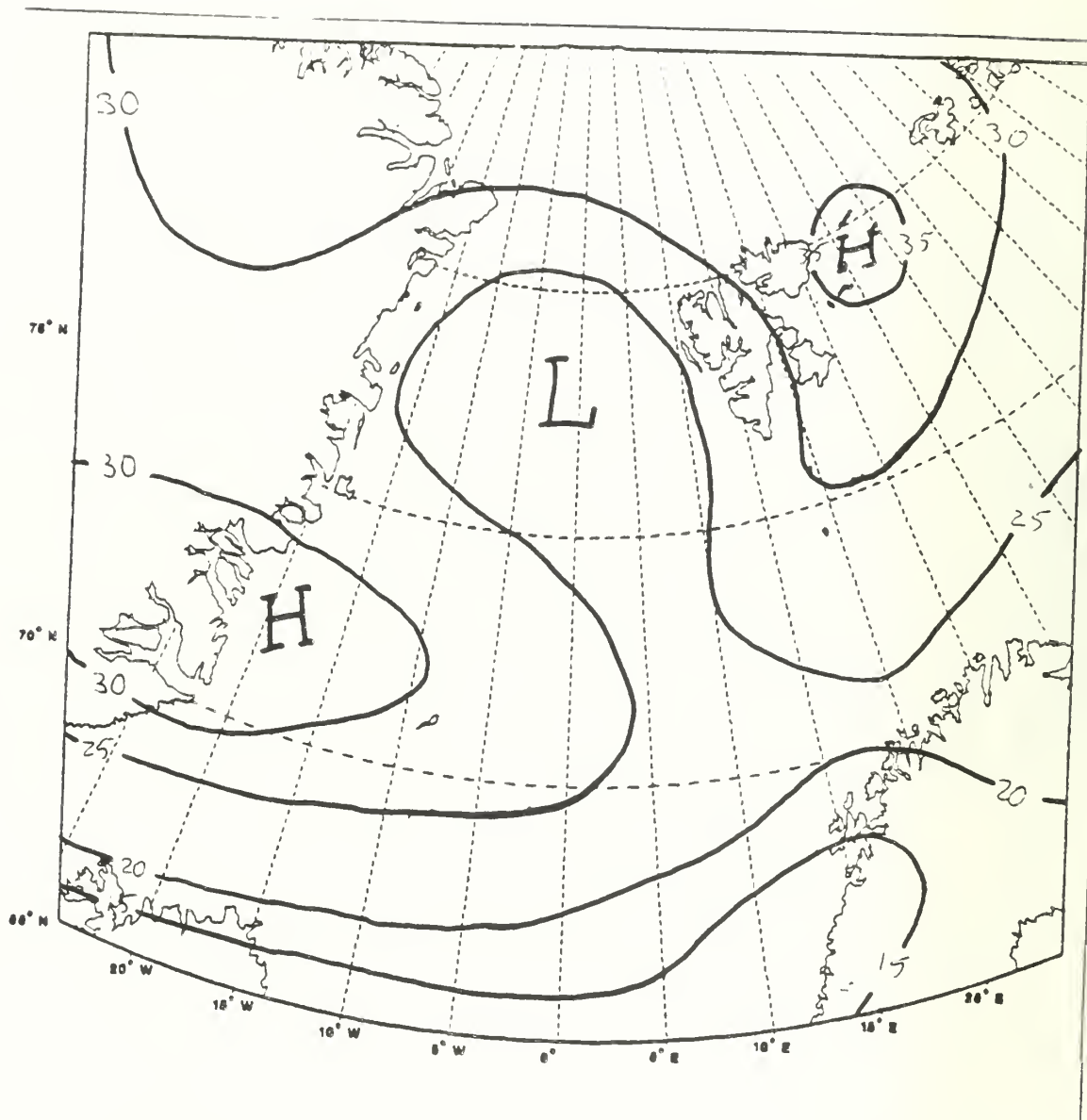
MIZEX 24 MARCH 1987



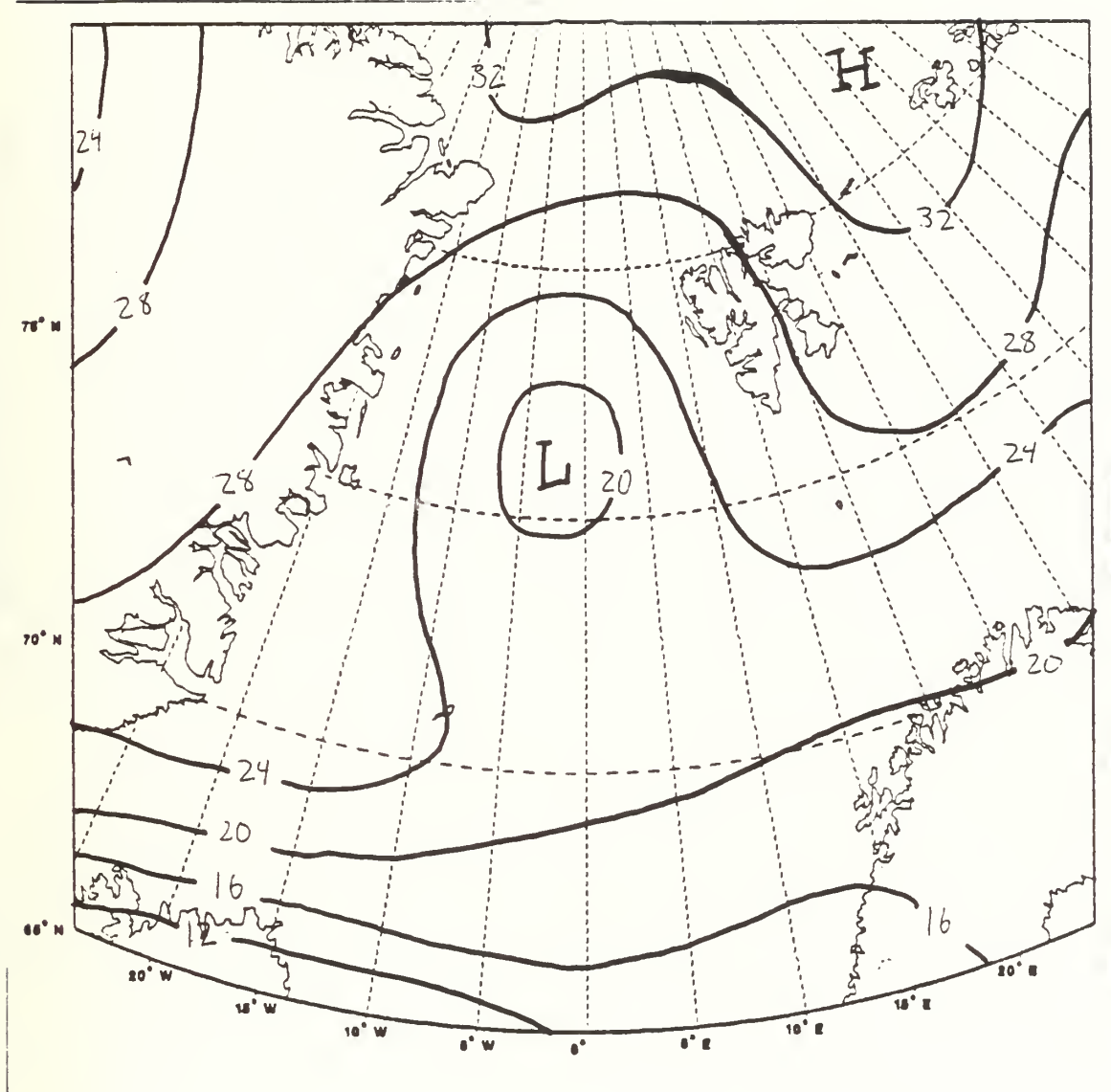




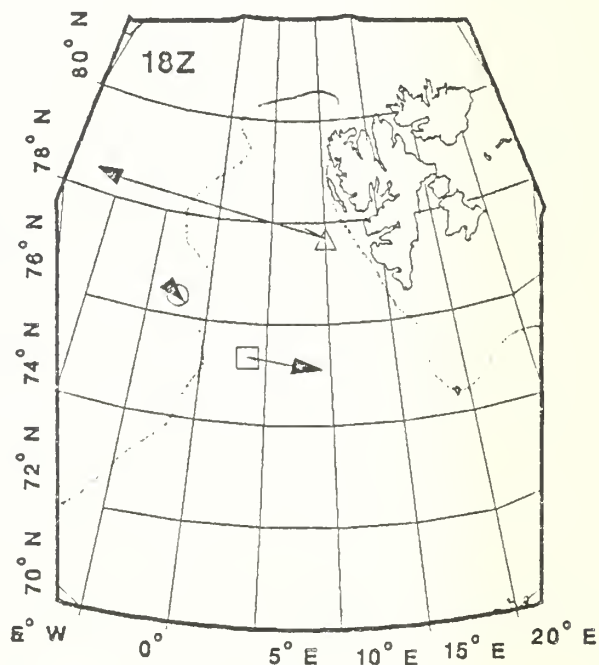
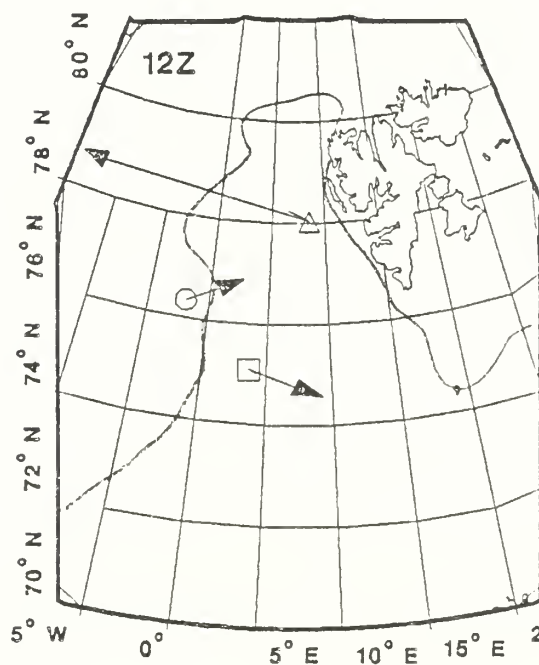
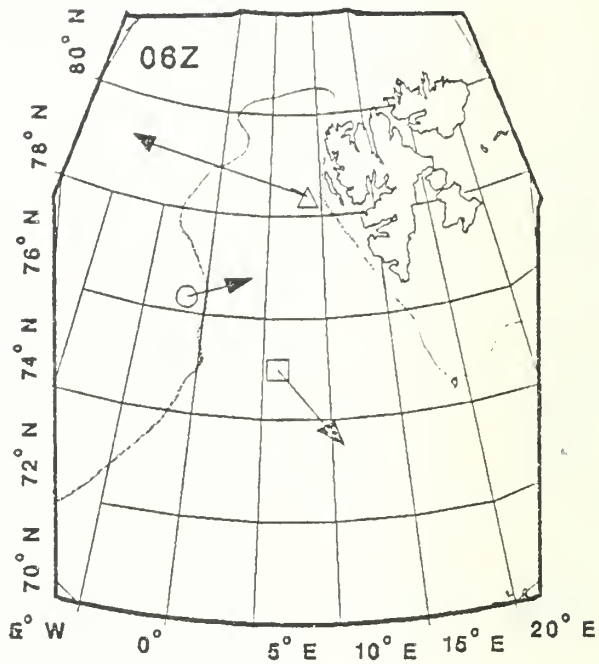
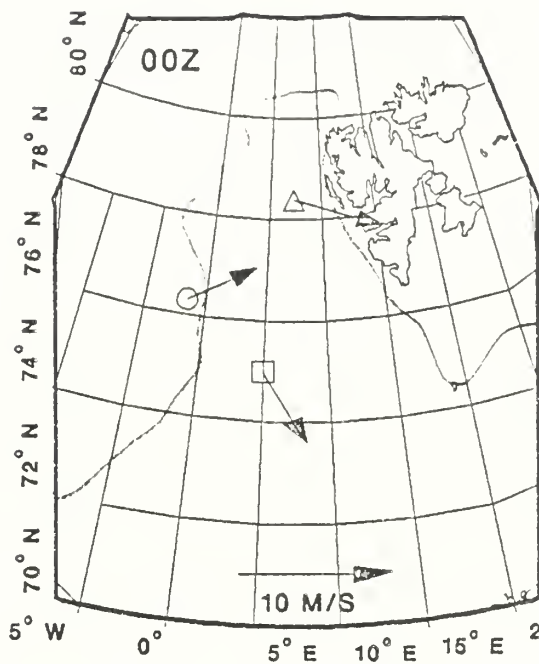




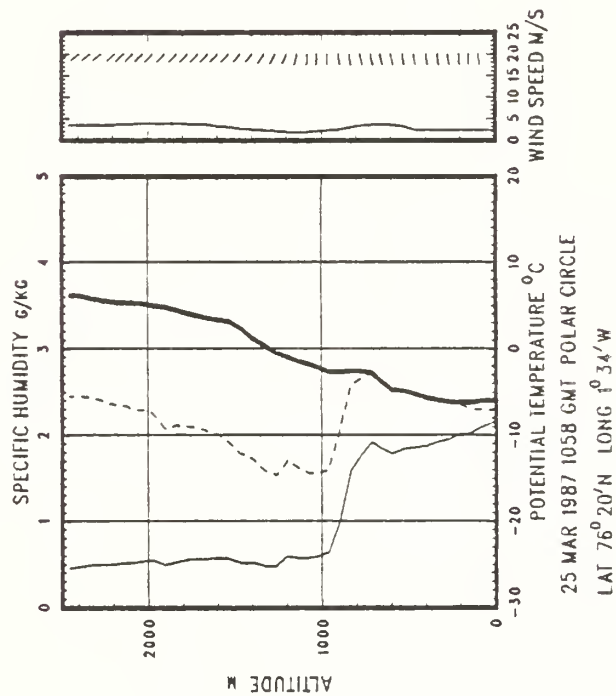
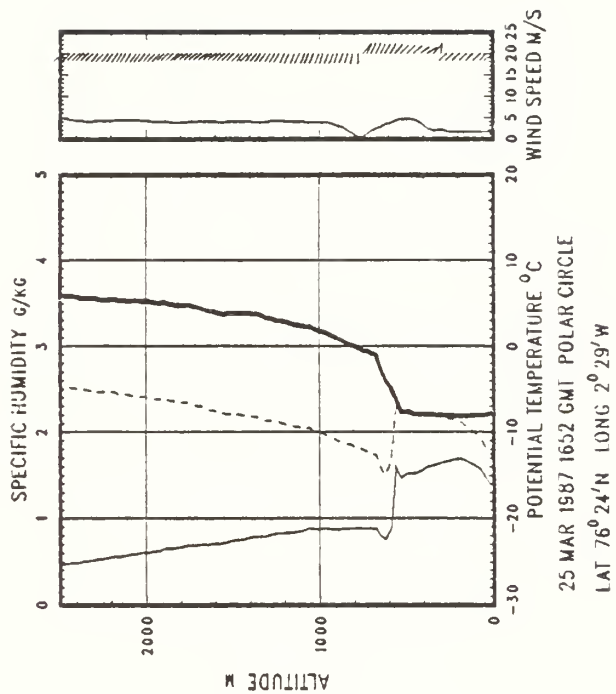
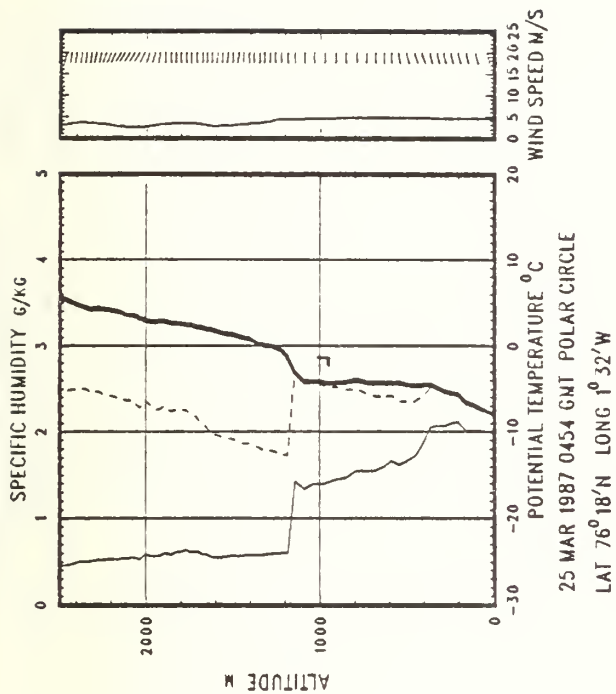
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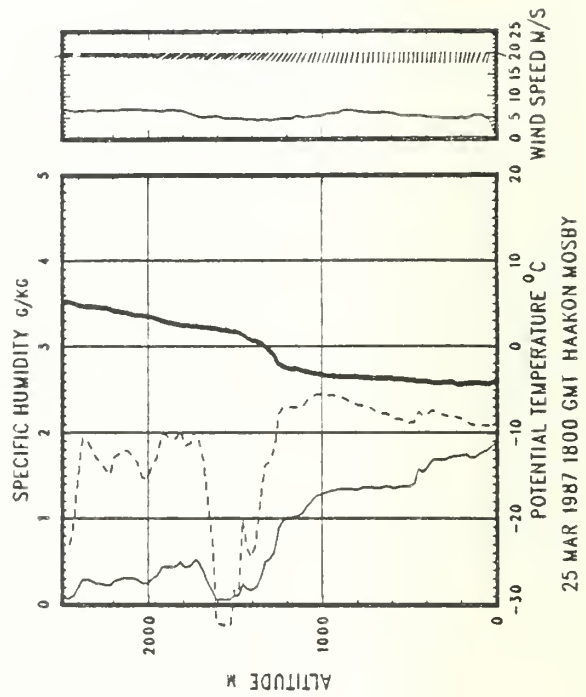
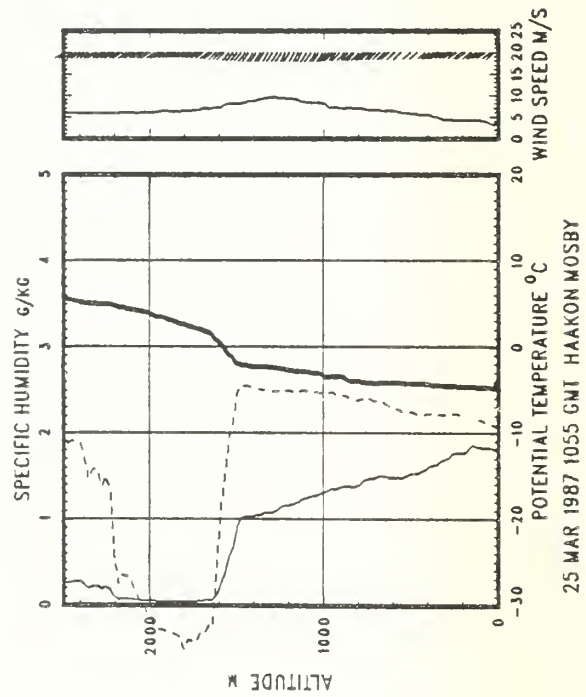


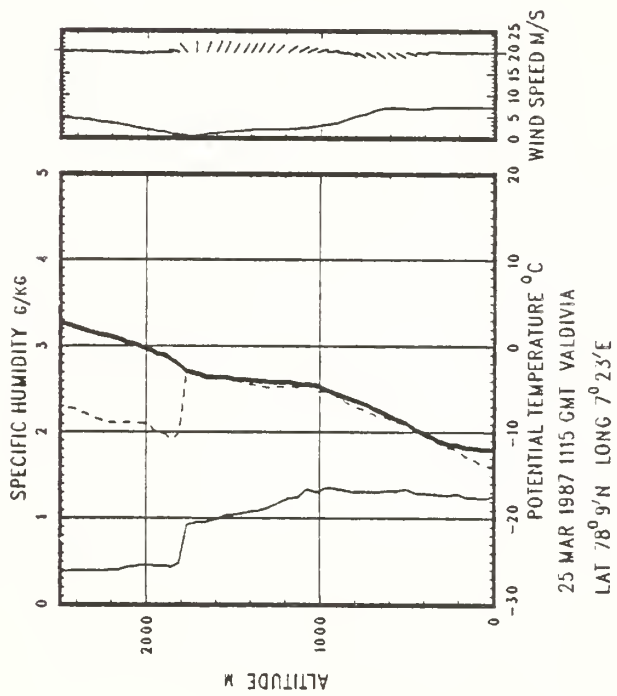
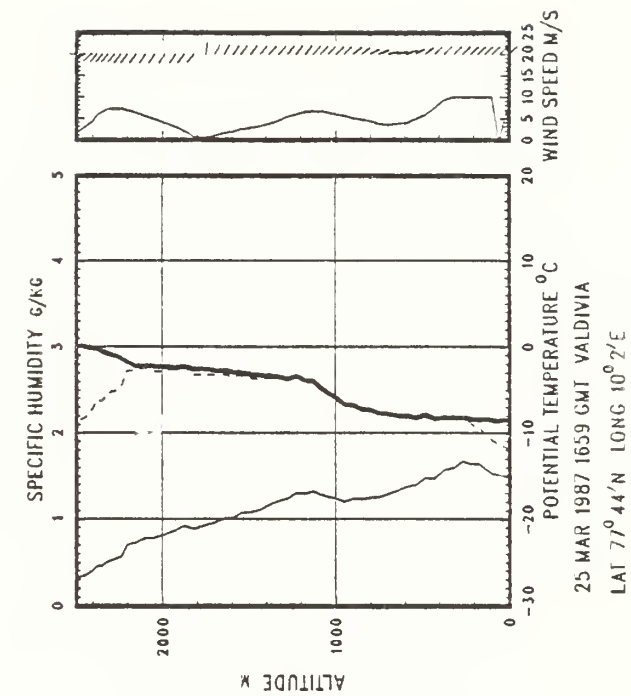
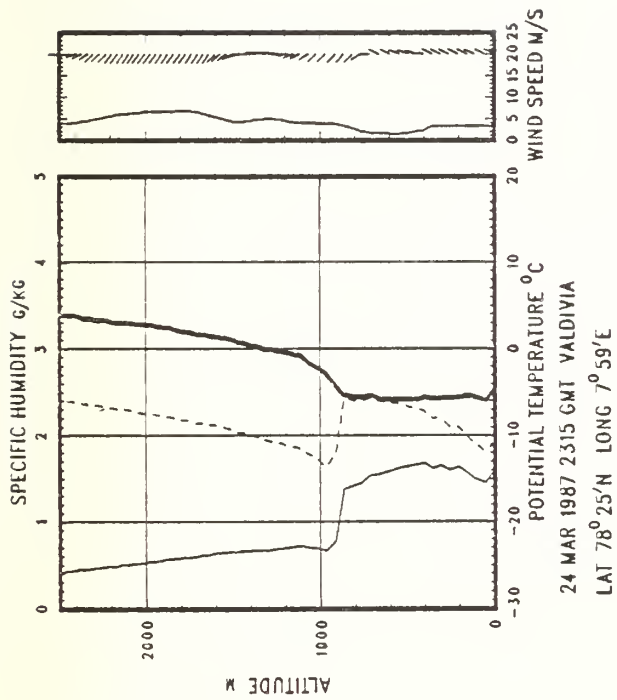
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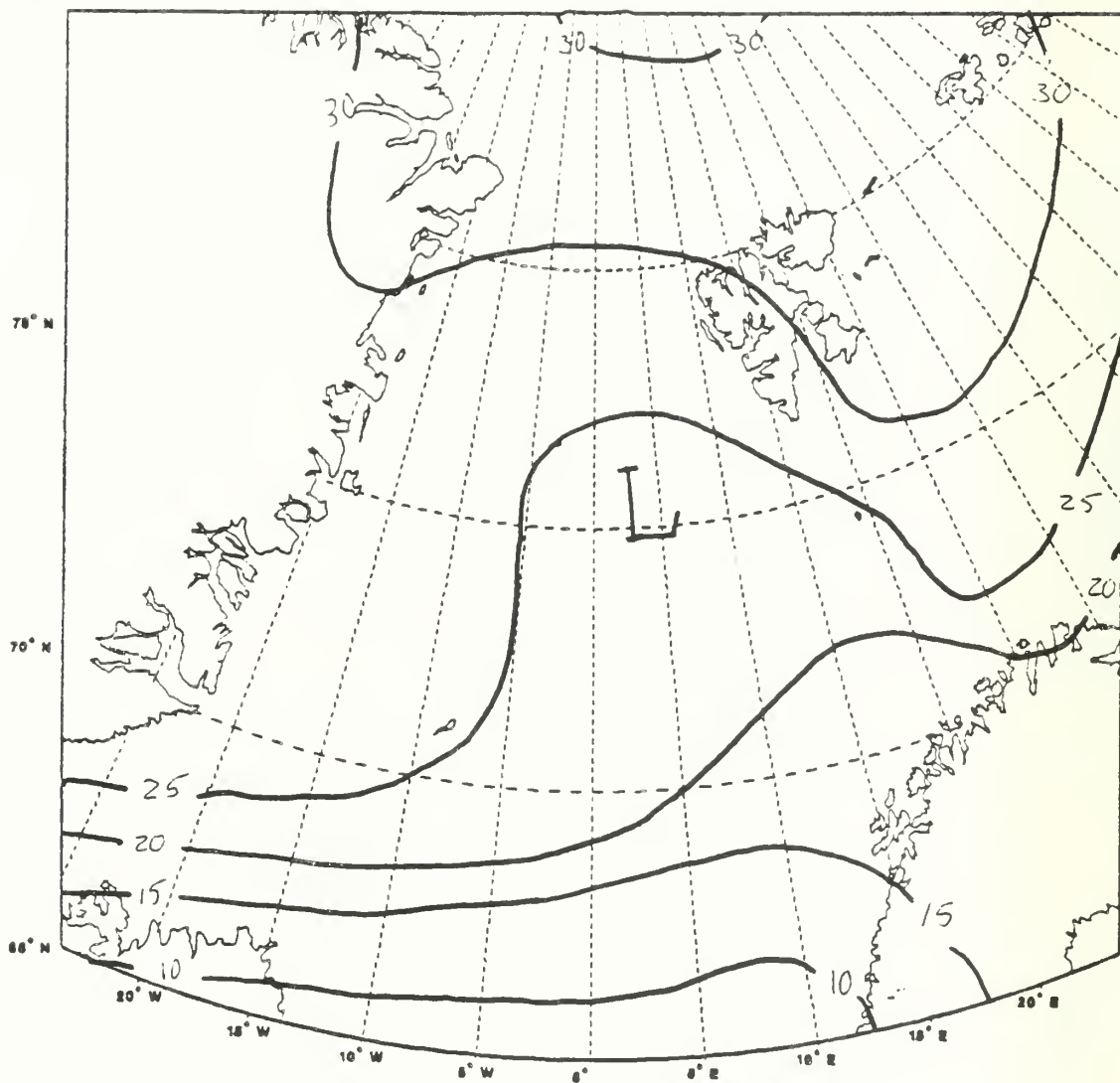


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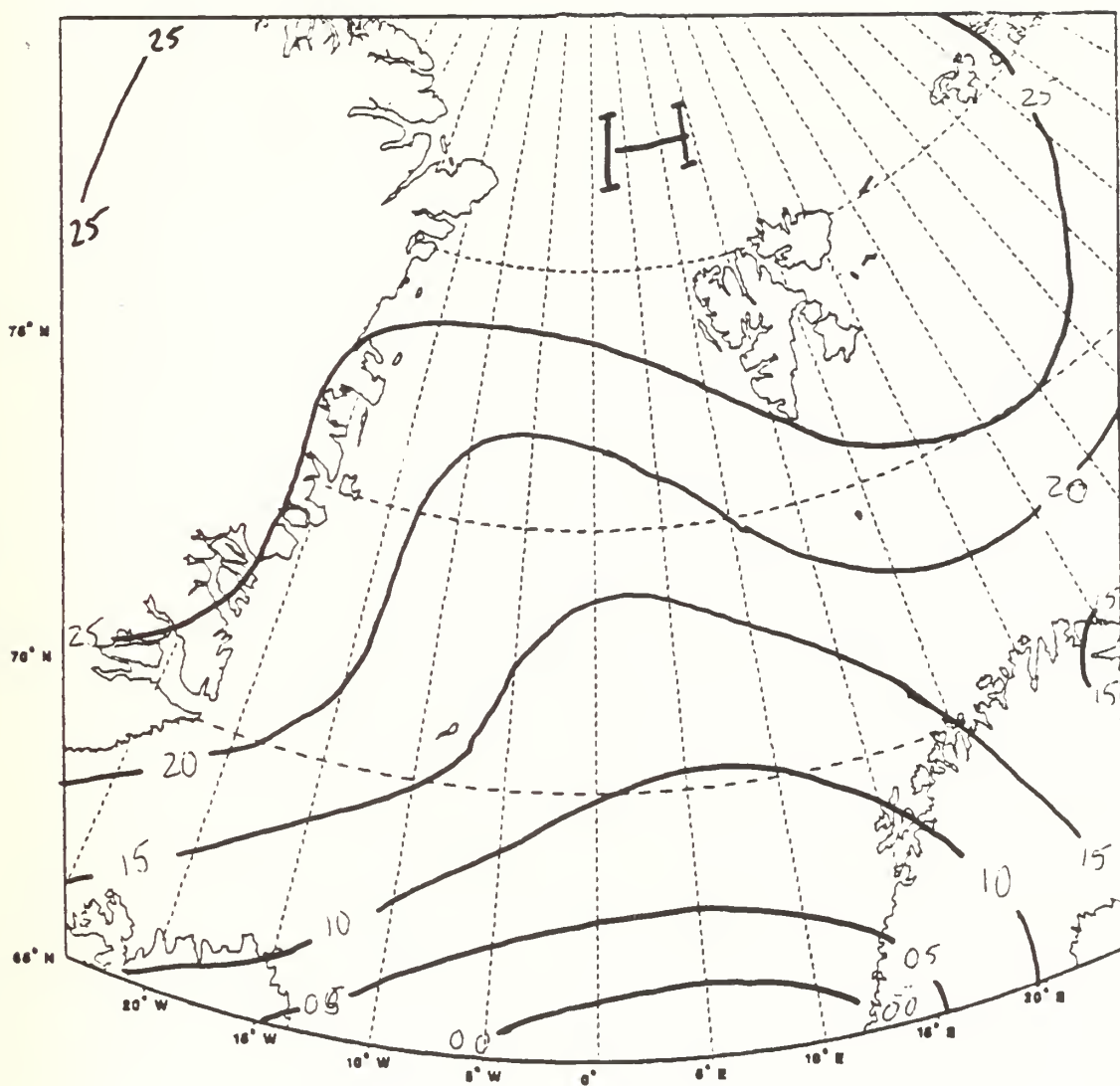




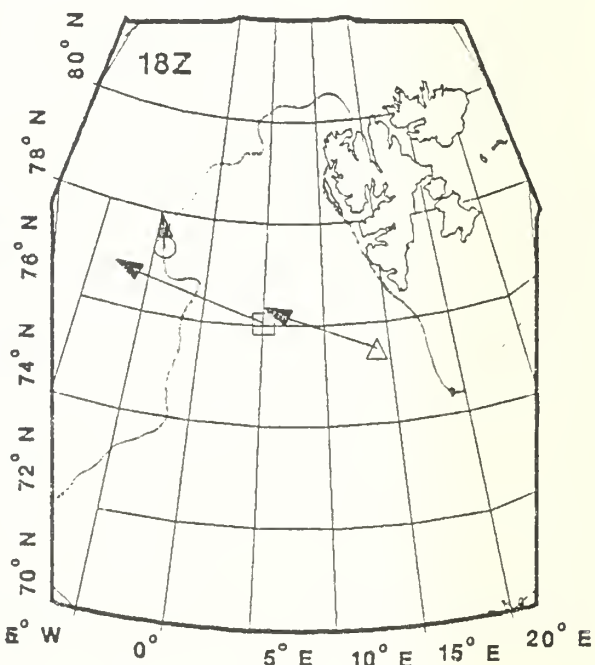
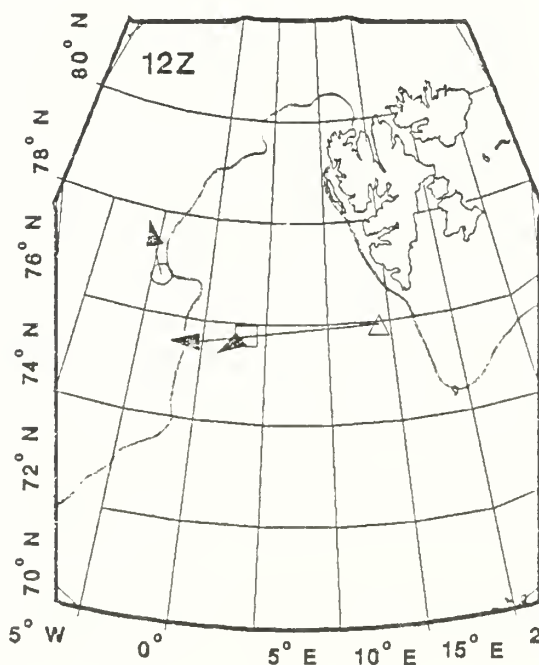
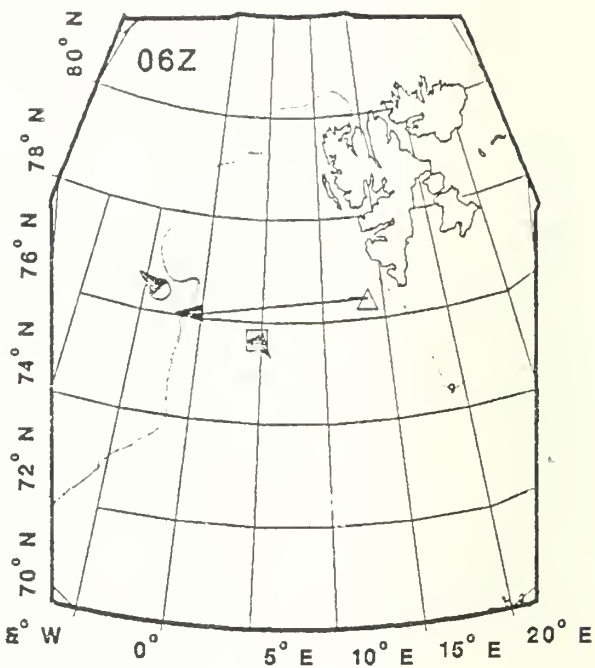
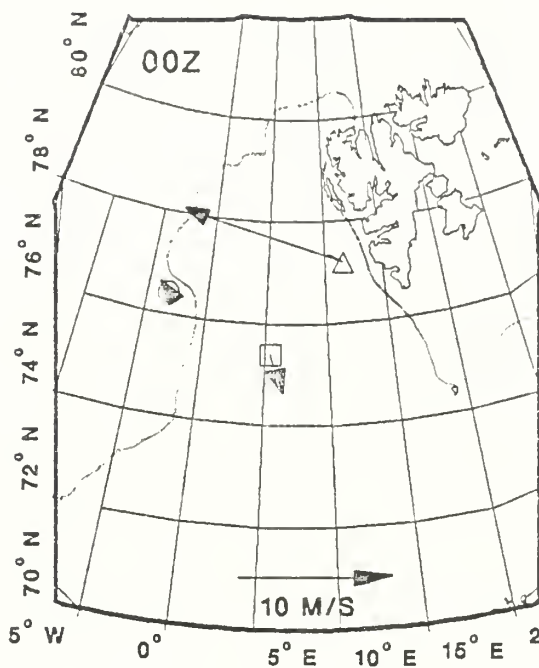




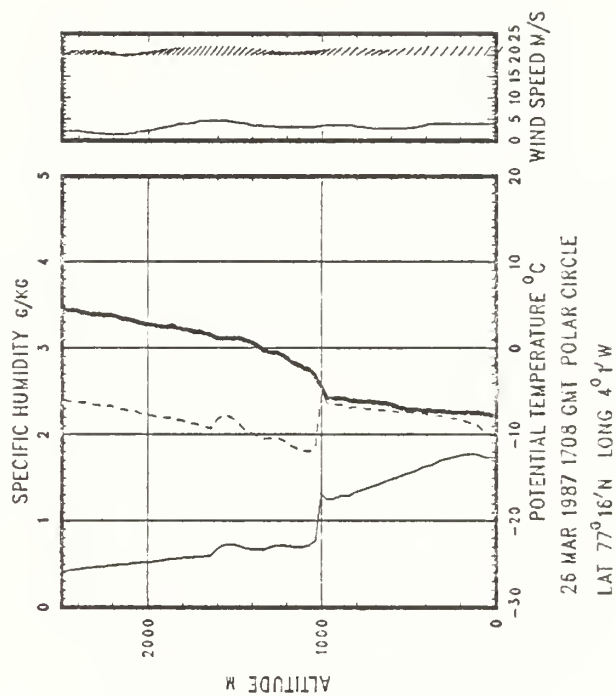
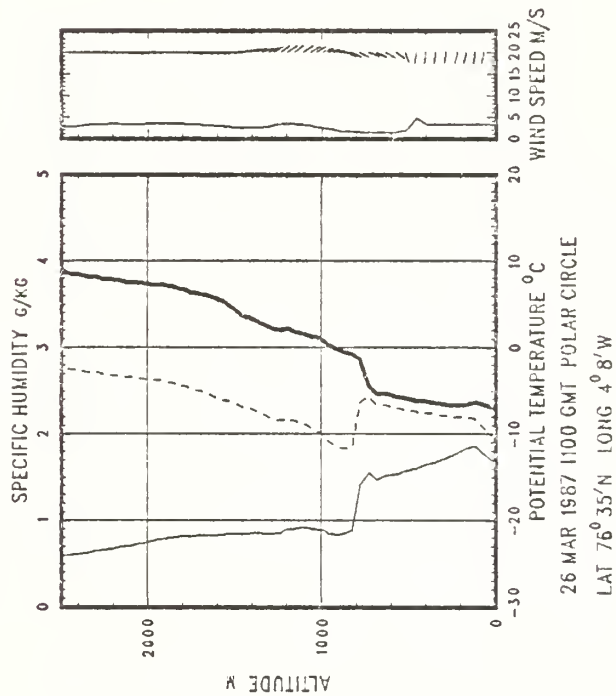
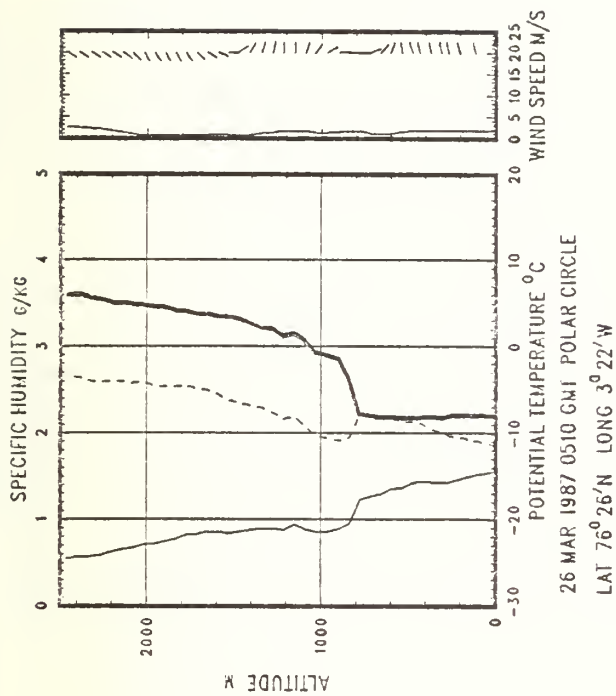
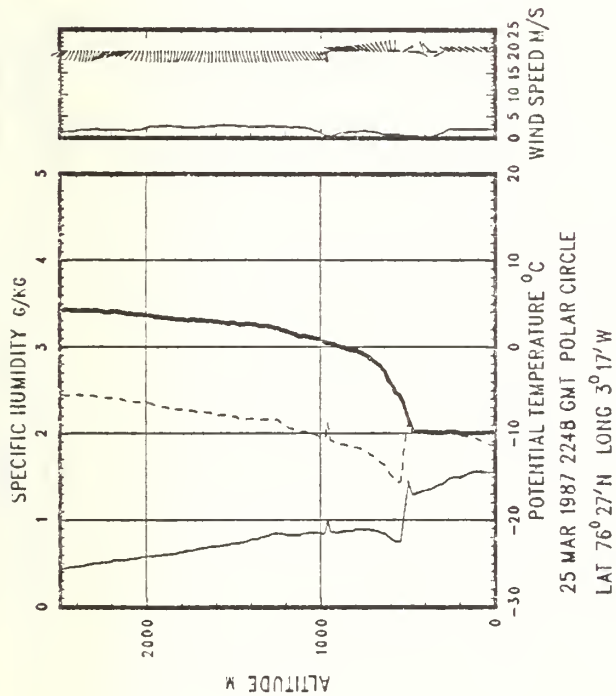
0000 UT 26 March 1987

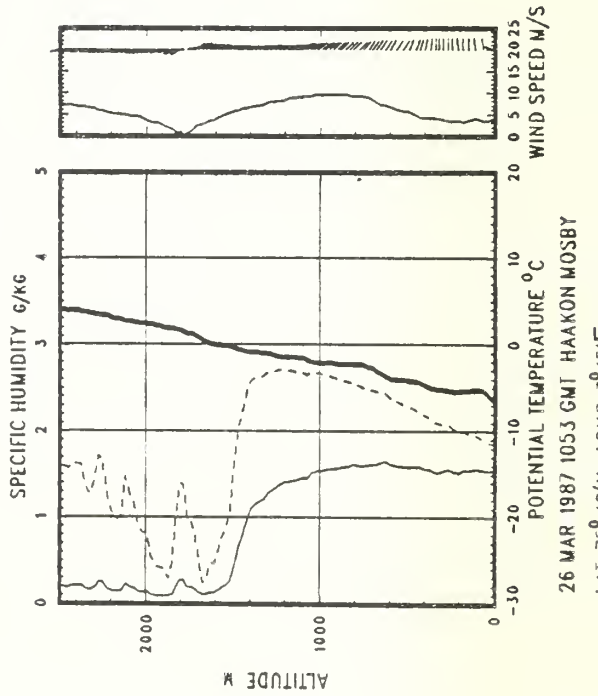
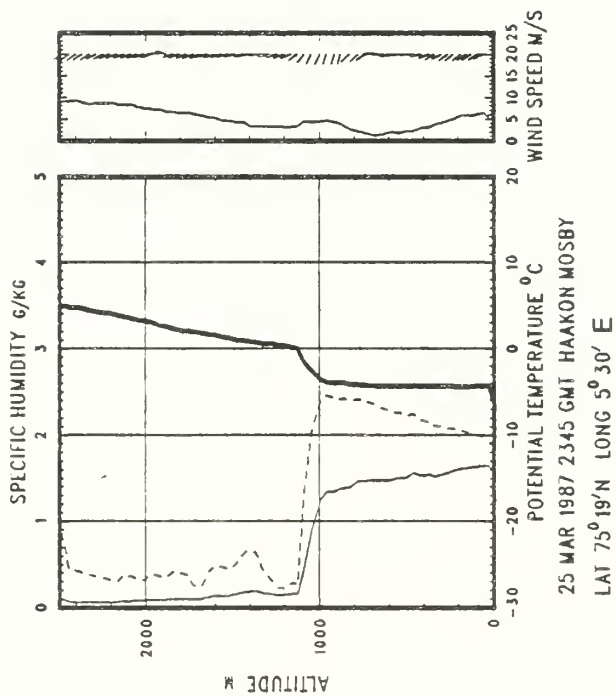
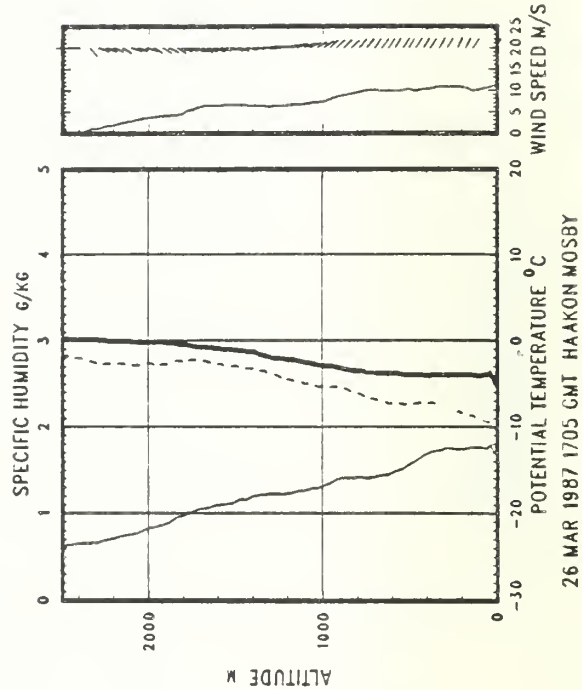
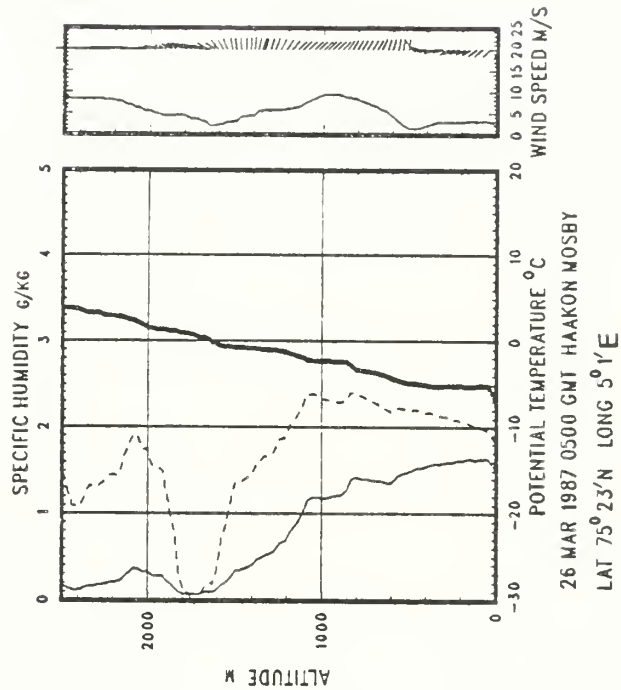


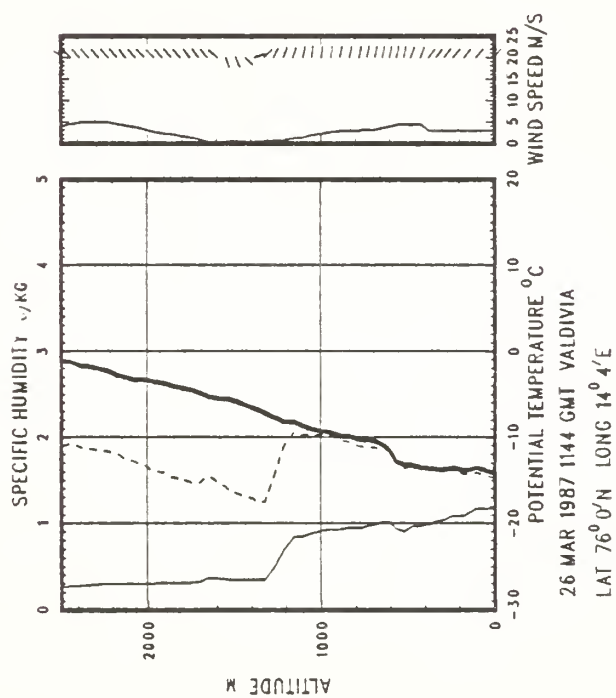
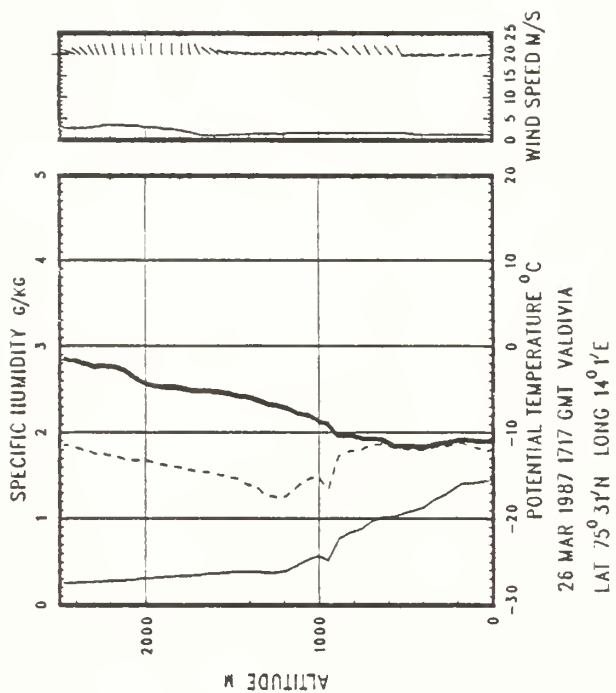
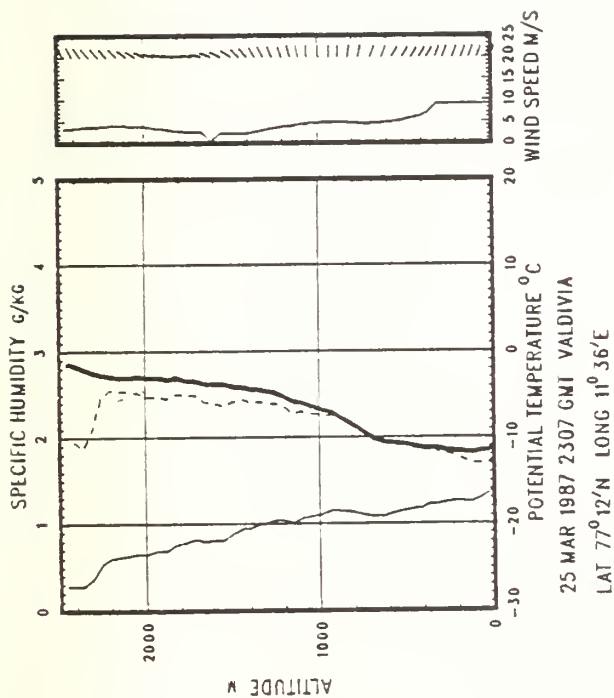
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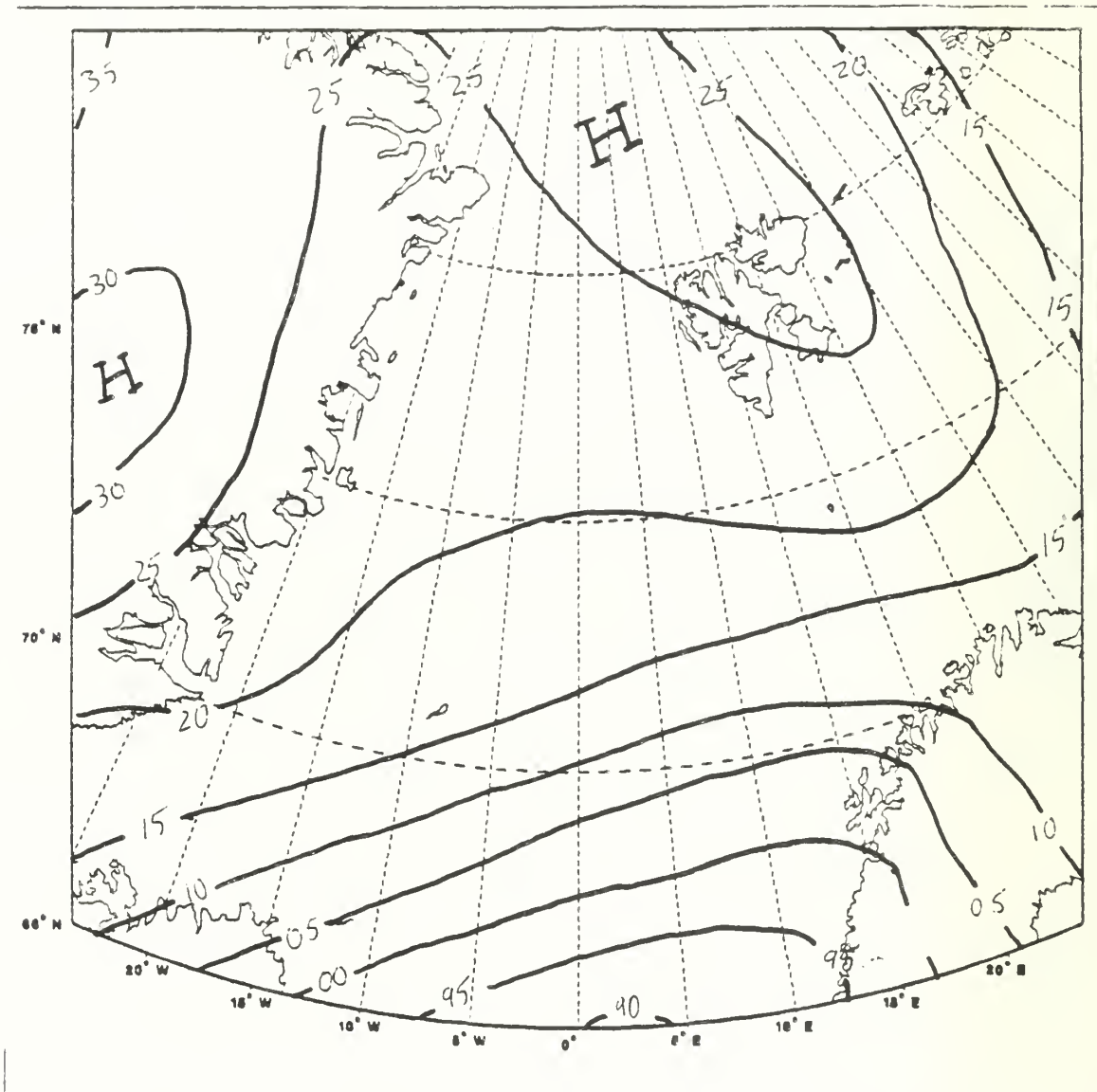


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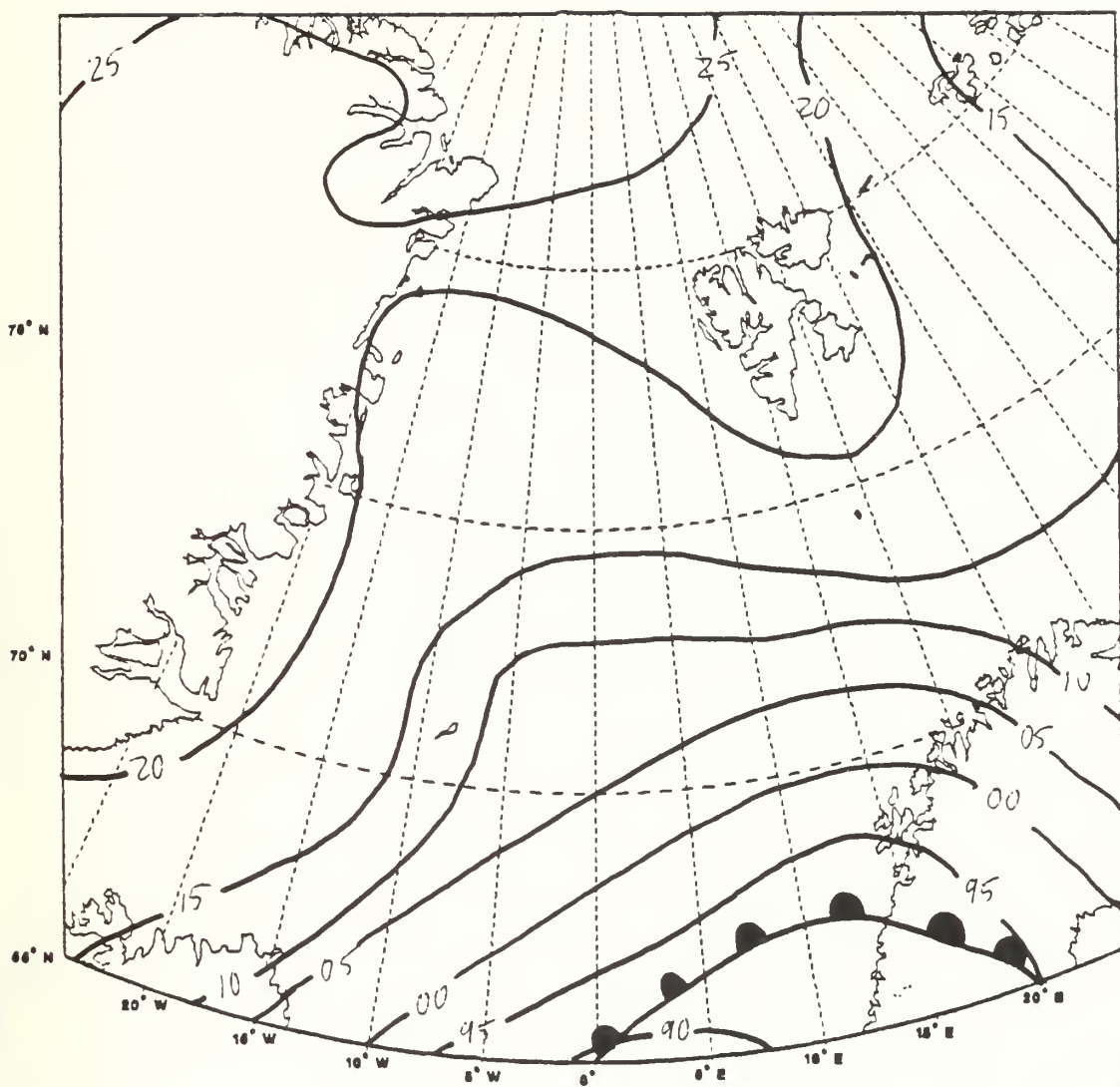




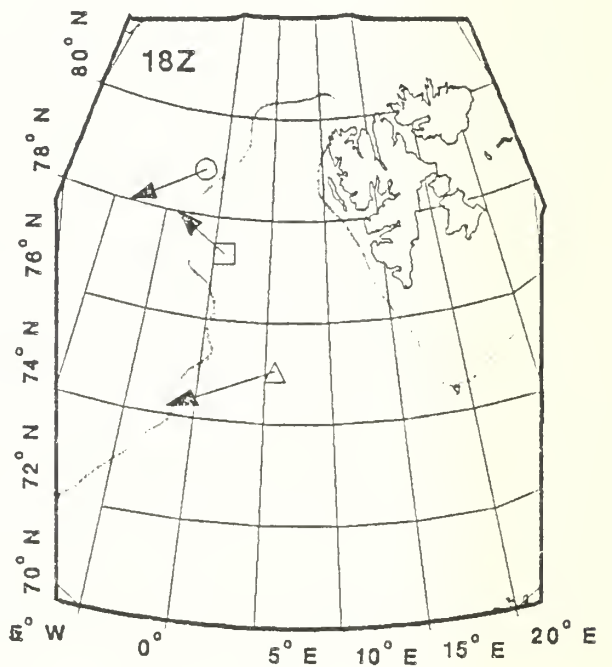
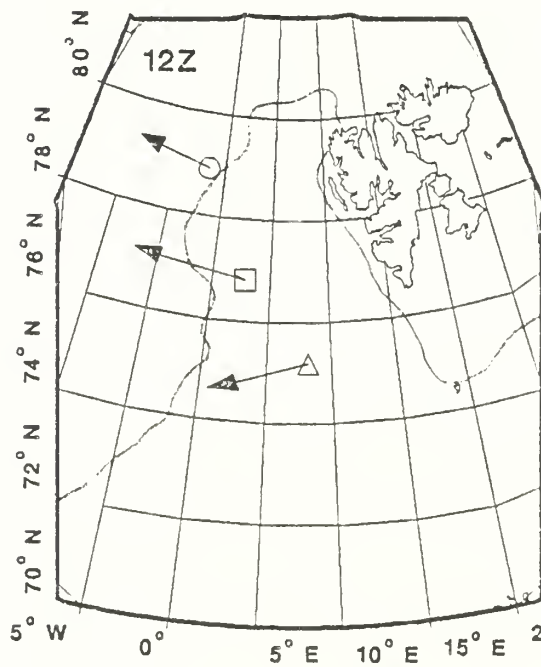
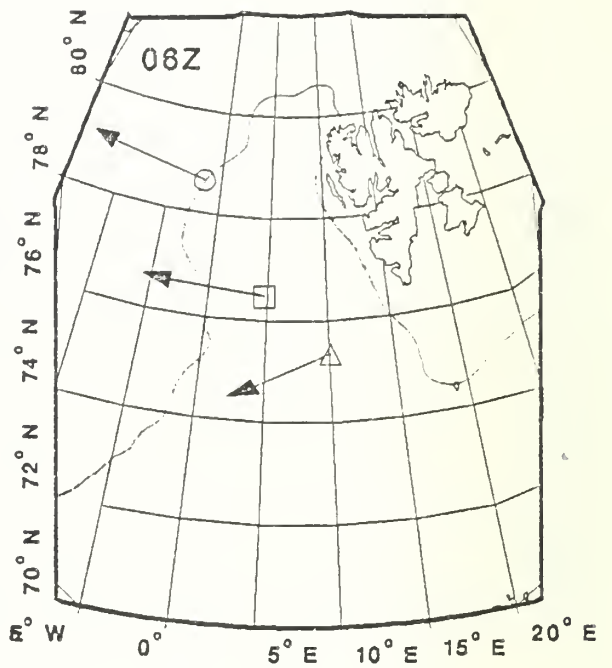
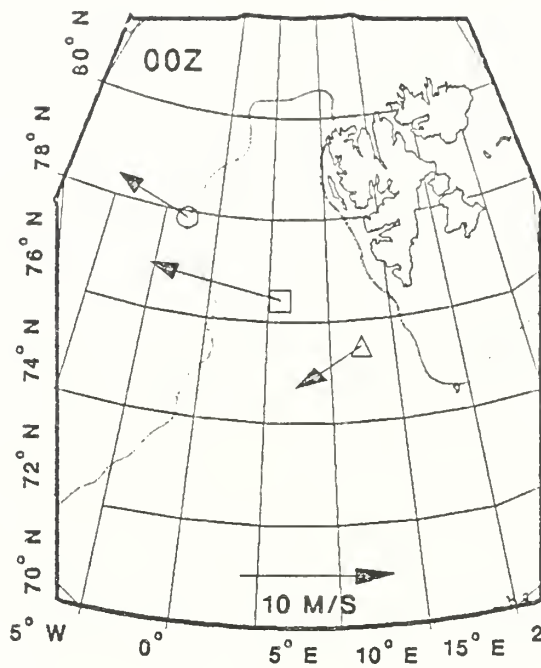




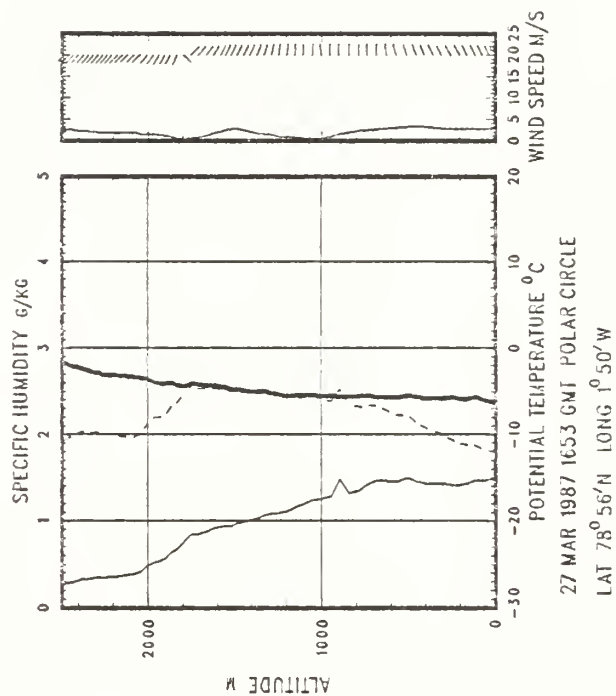
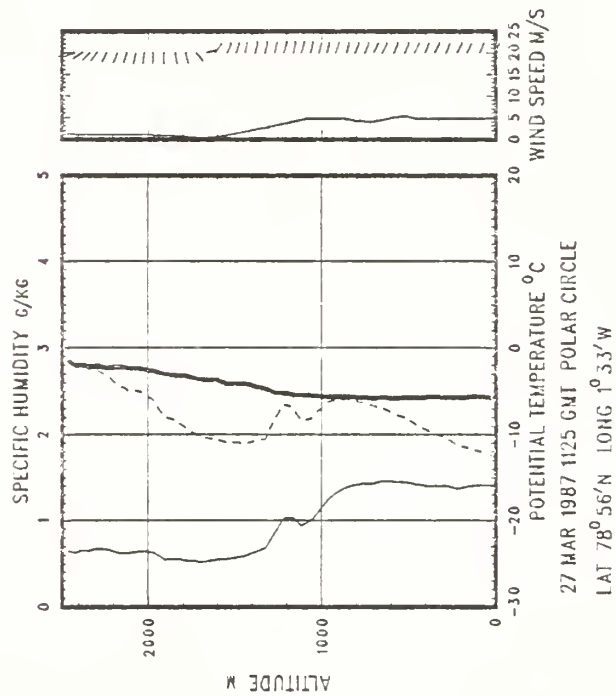
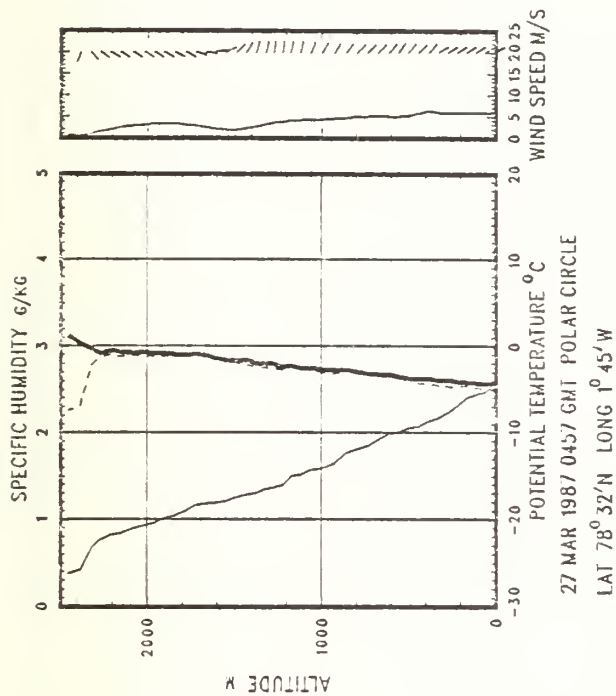
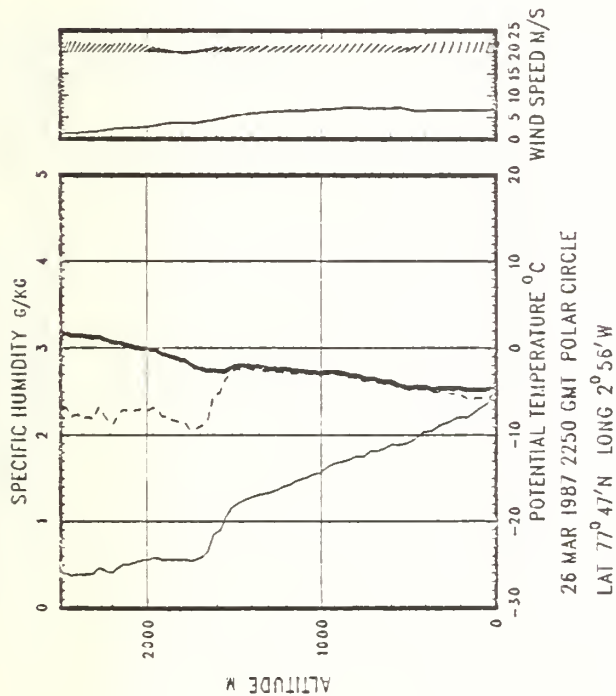
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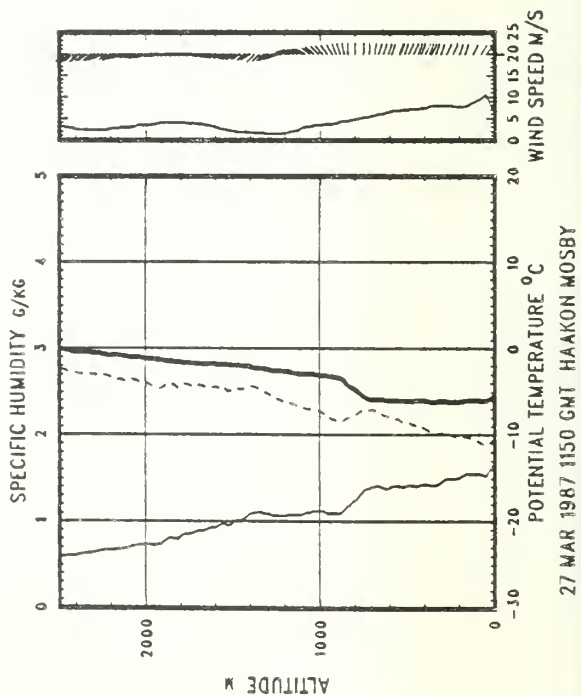
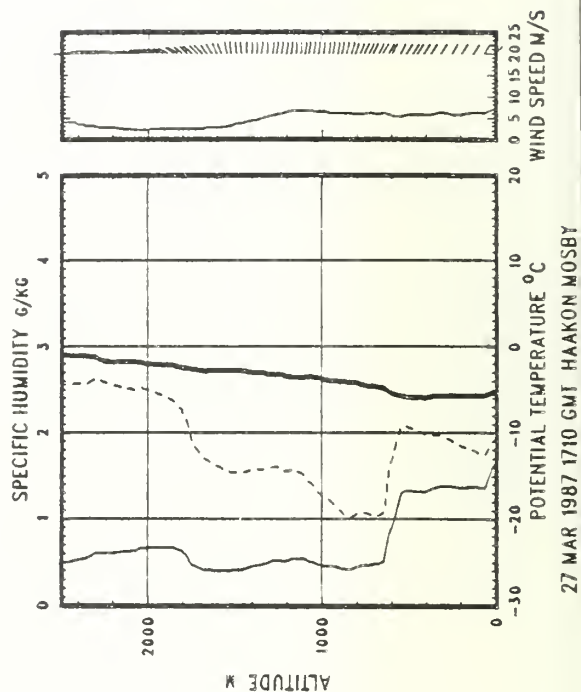
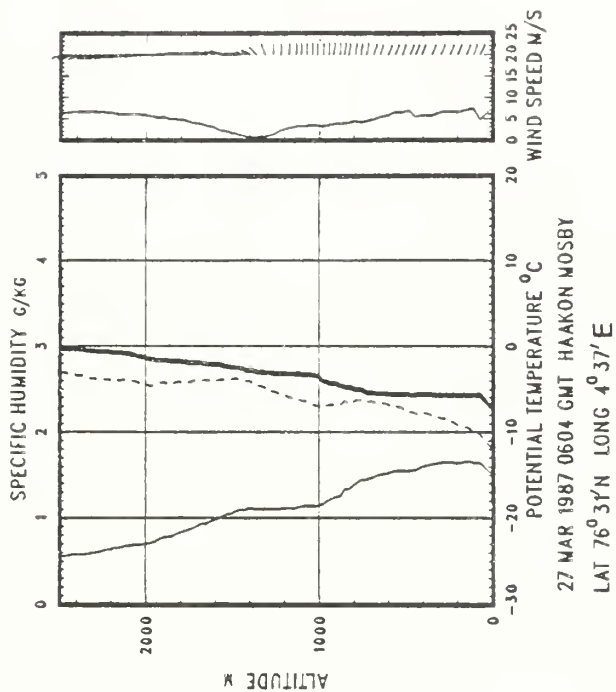


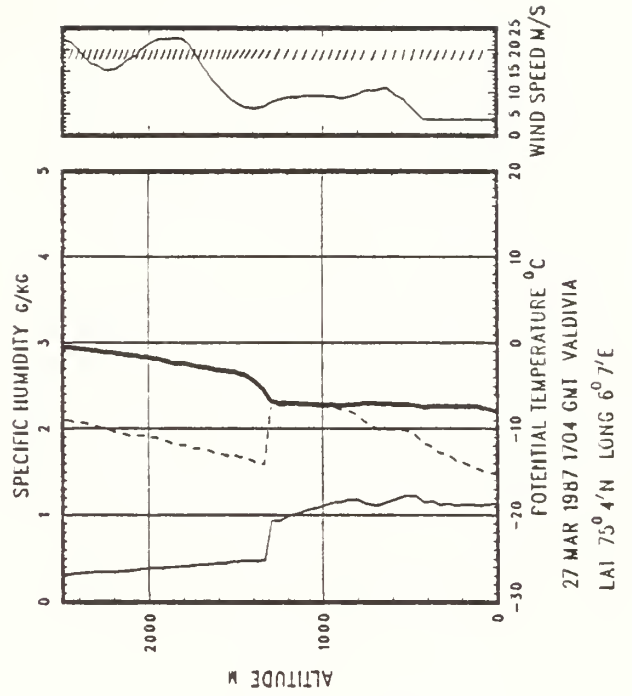
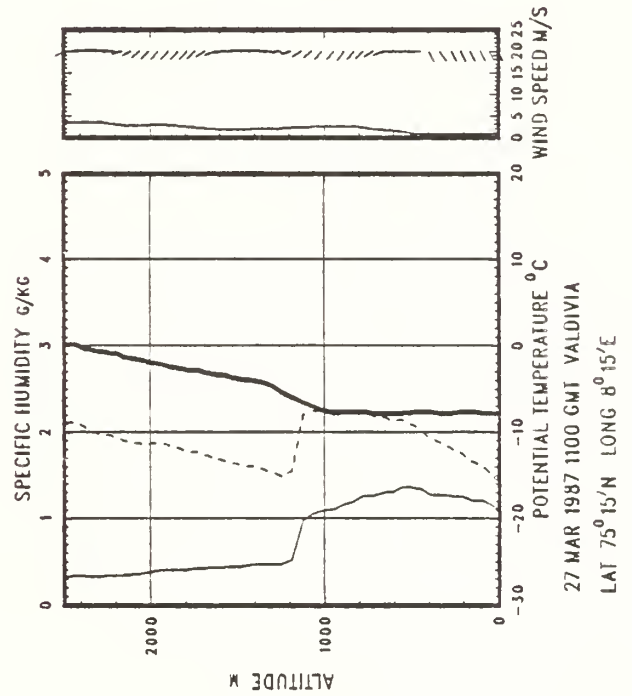
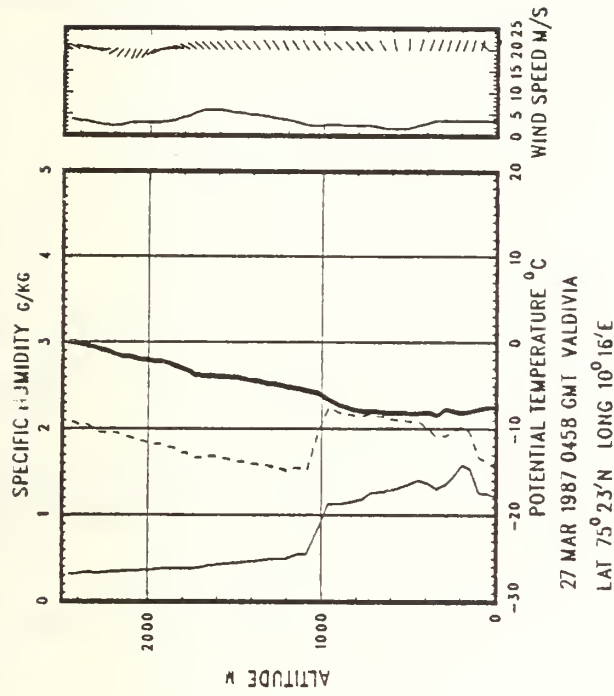
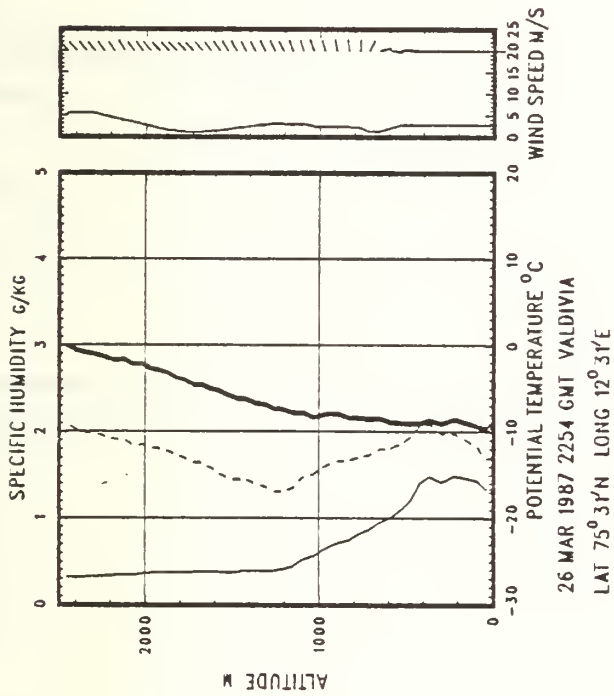
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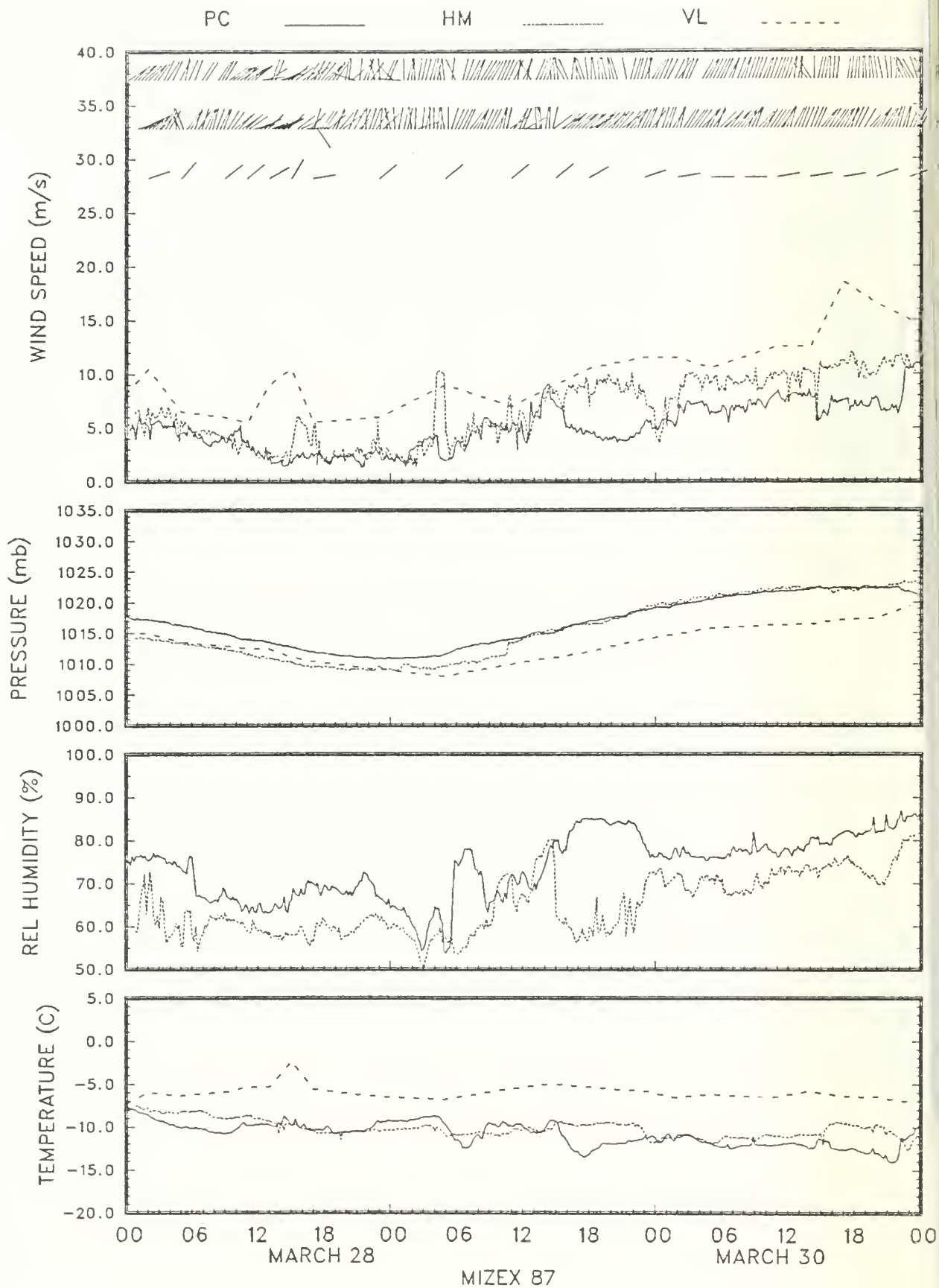


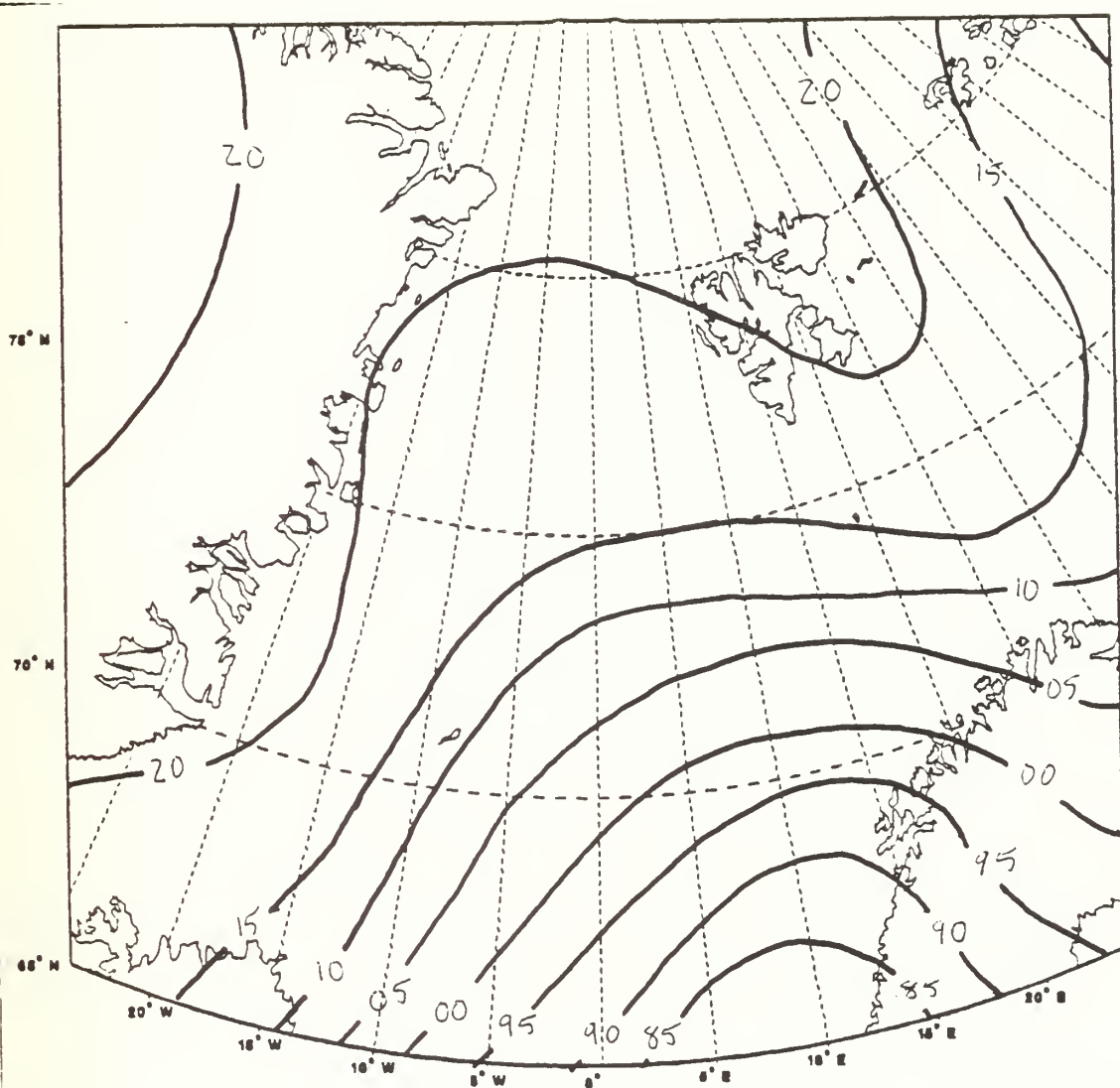
MIZEX 27 MARCH 1987



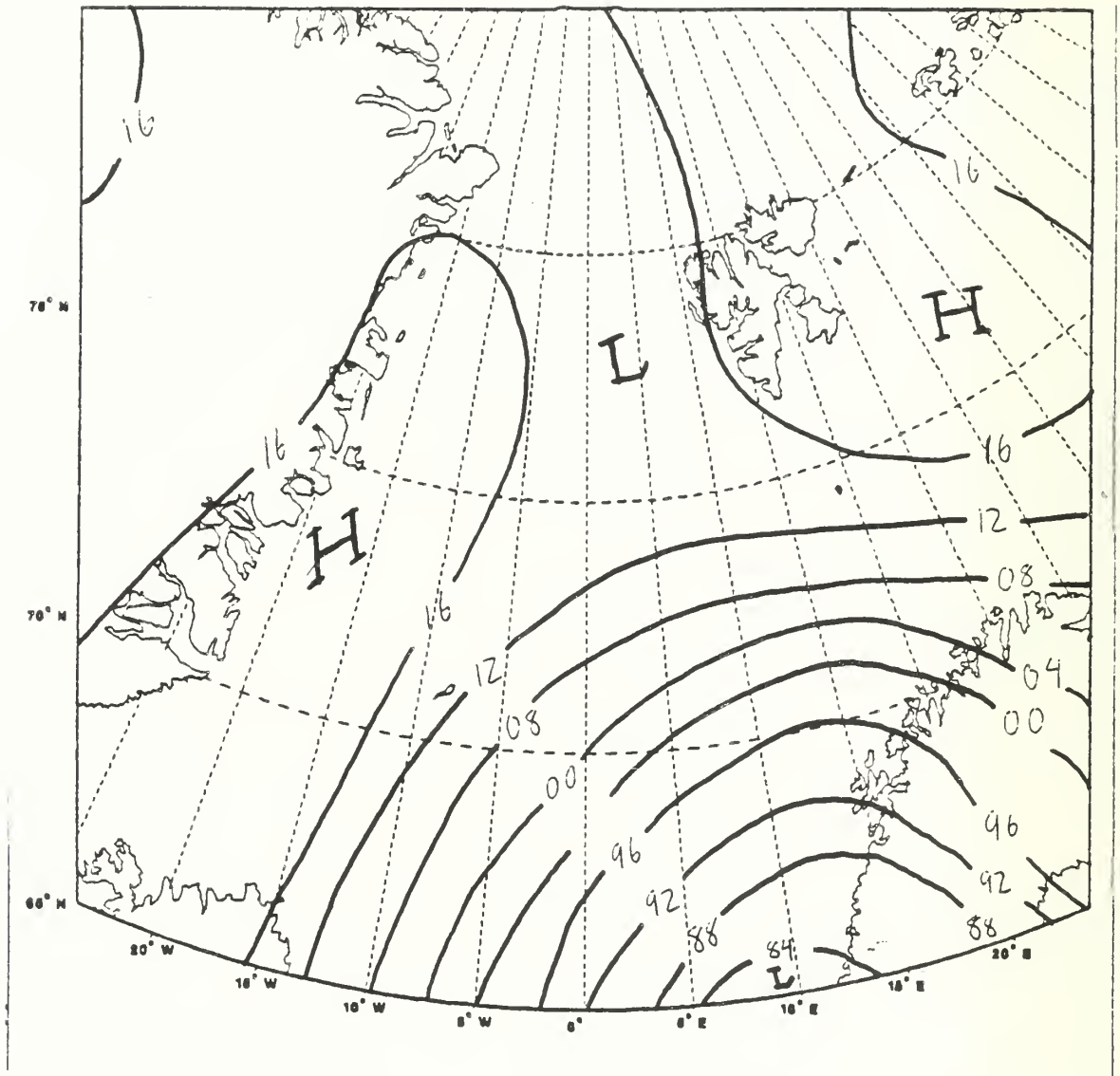




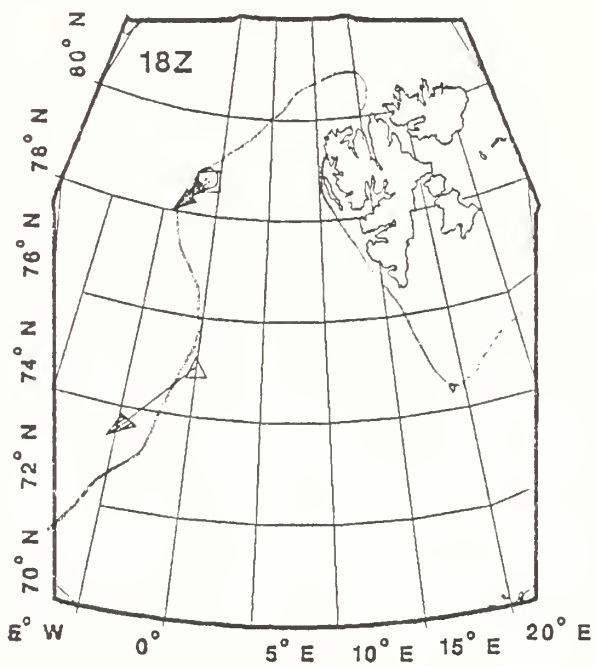
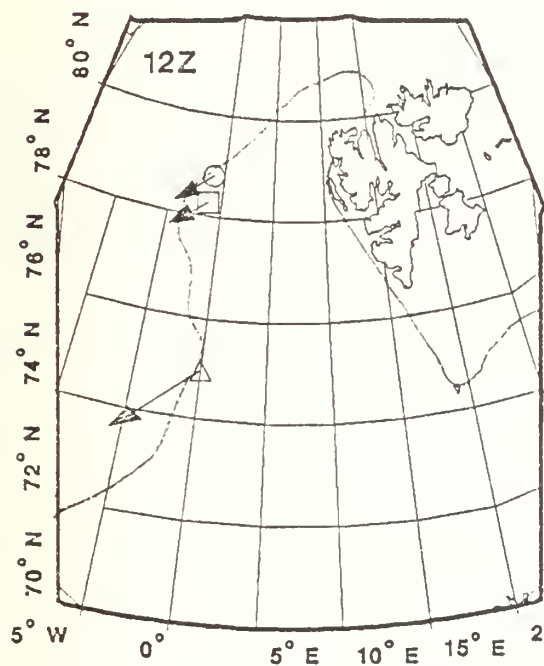
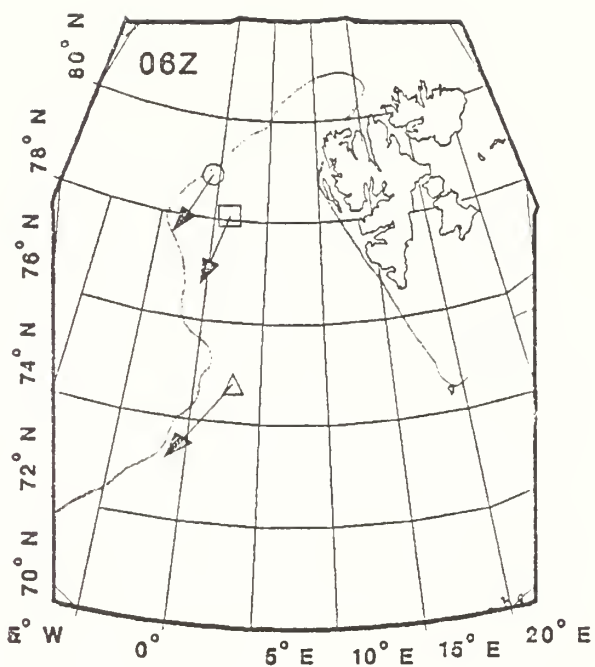
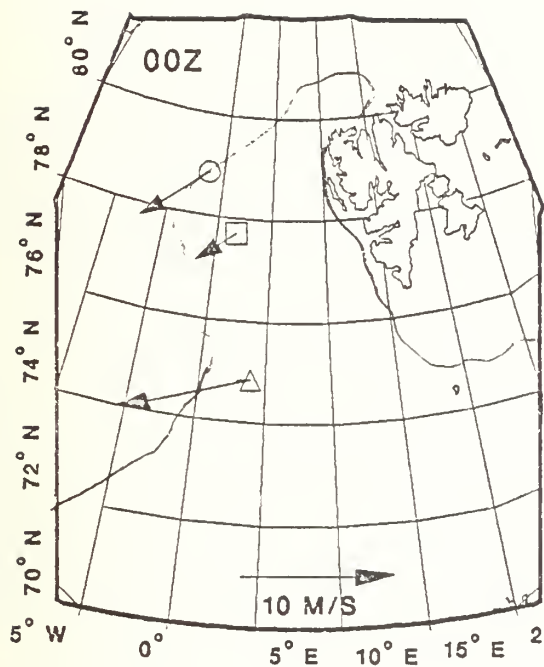




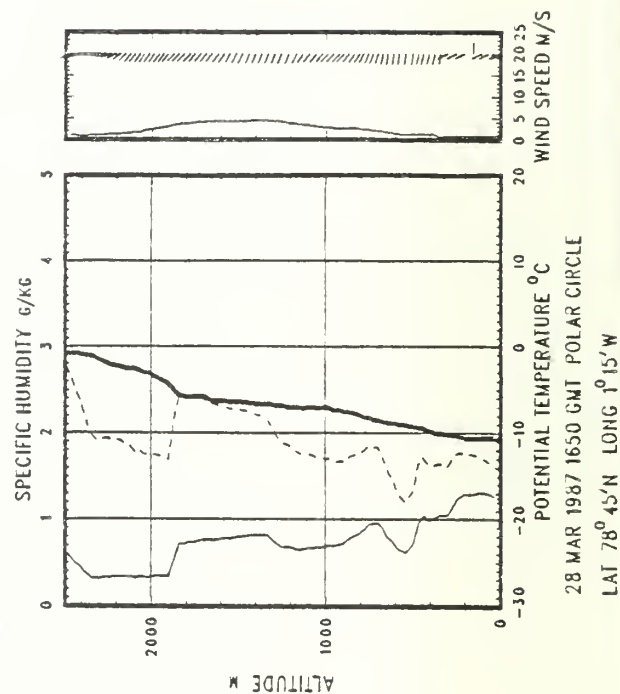
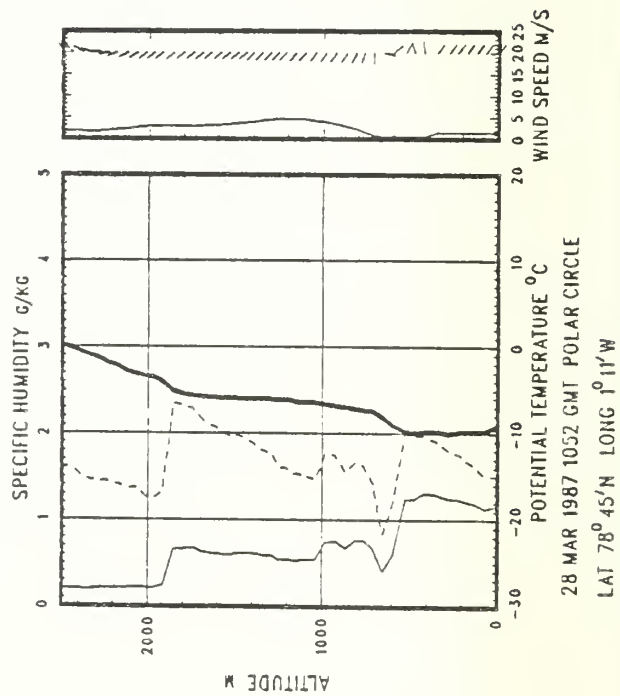
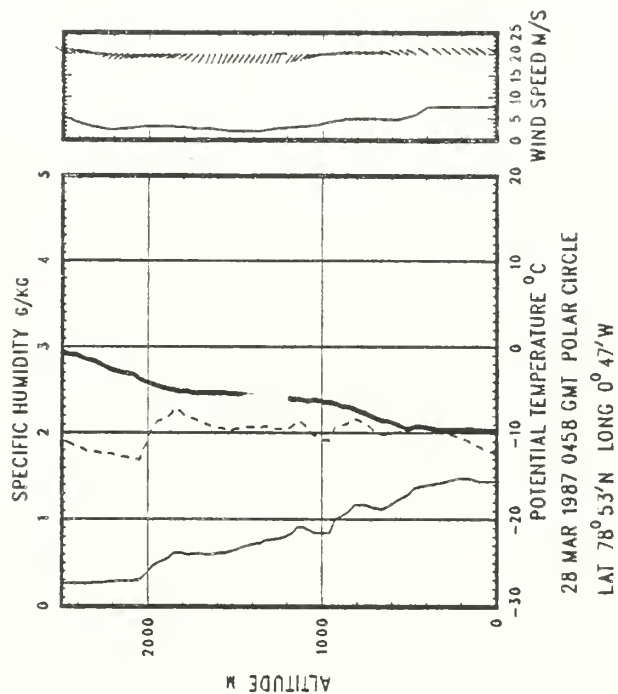
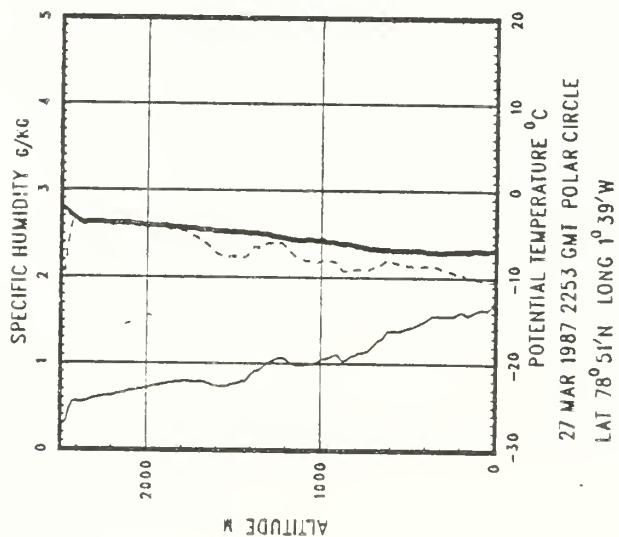
0000 UT 28 March 1987

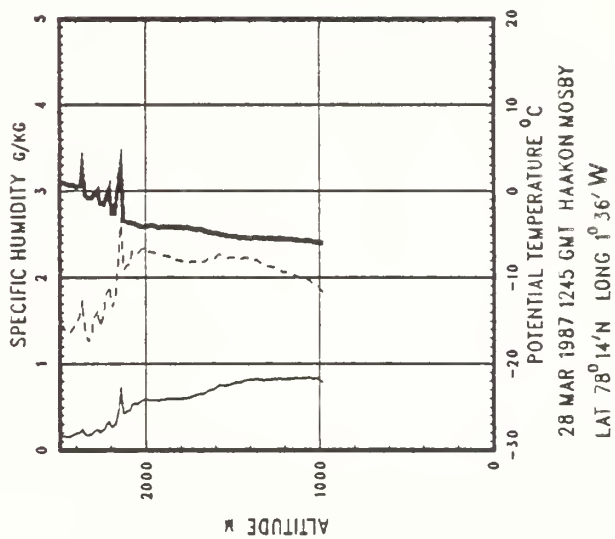
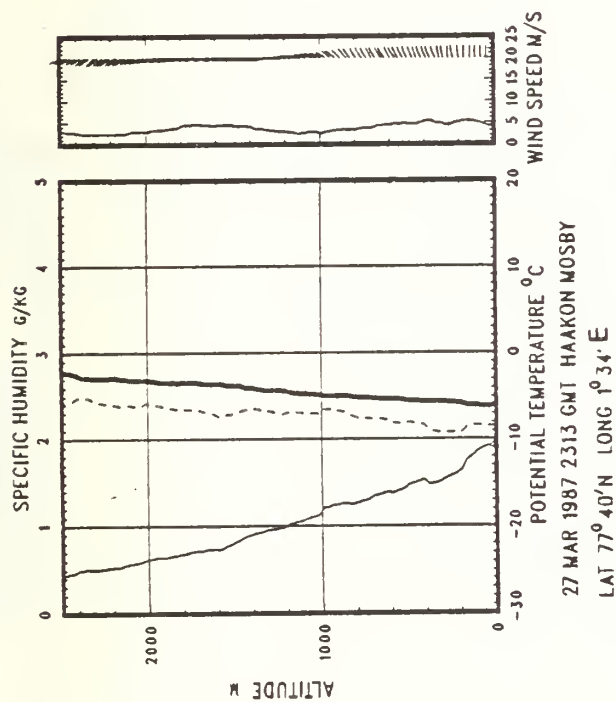
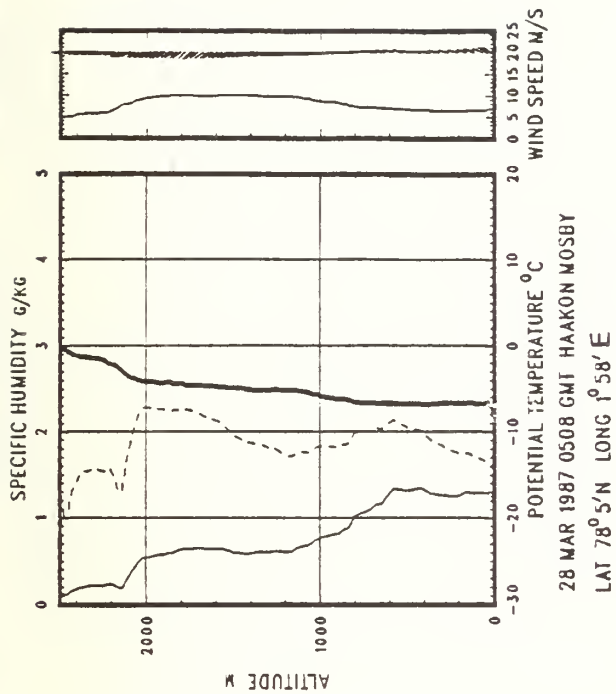


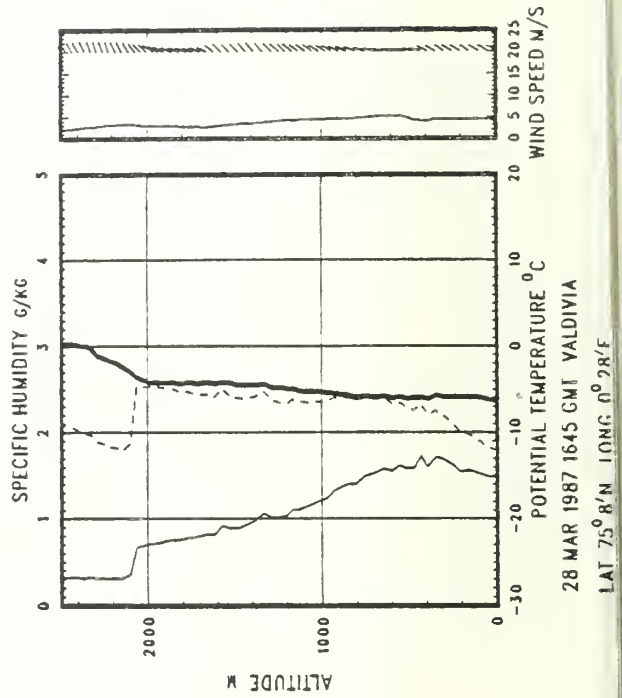
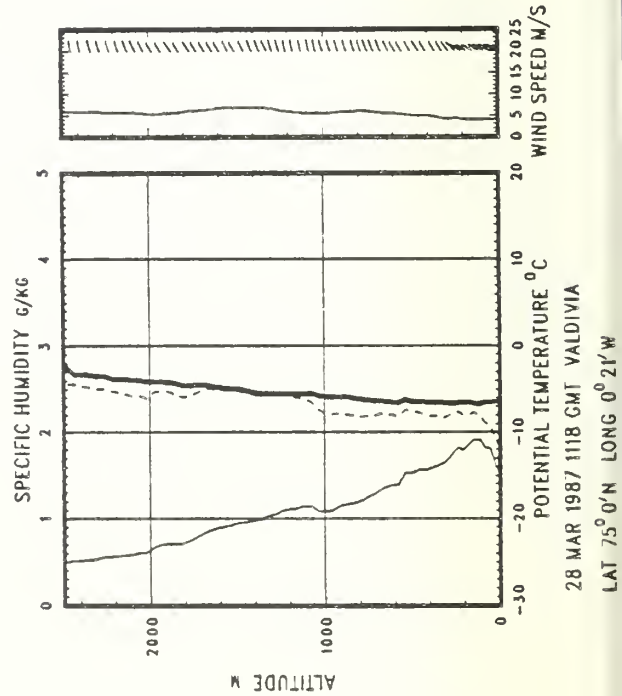
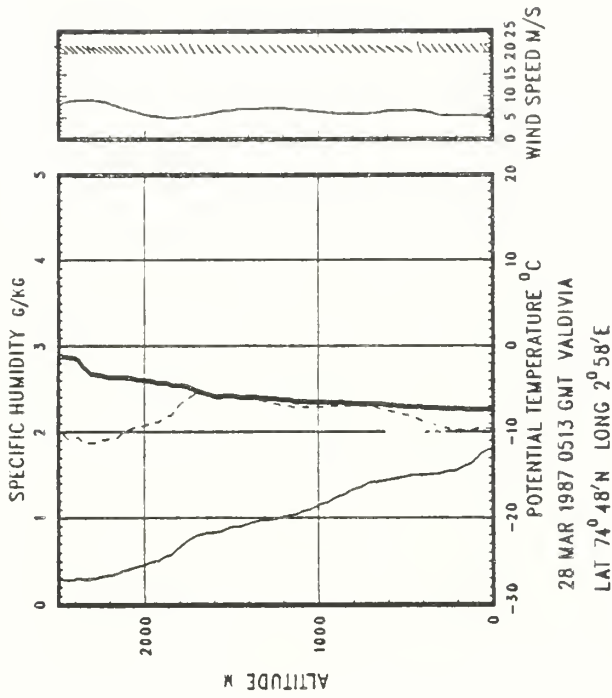
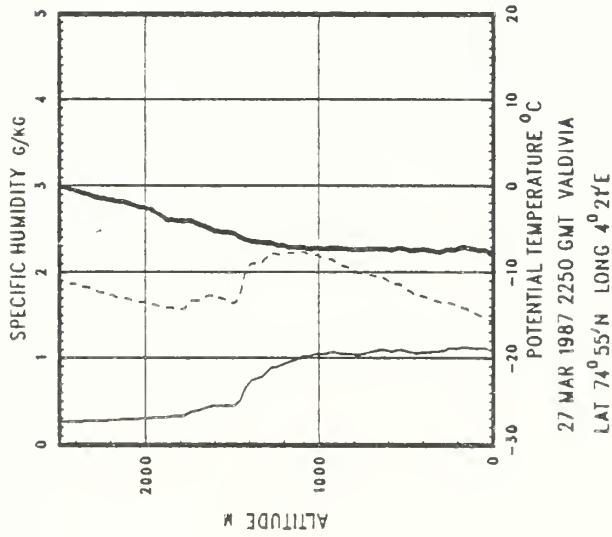
1200 UT 28 March 1987

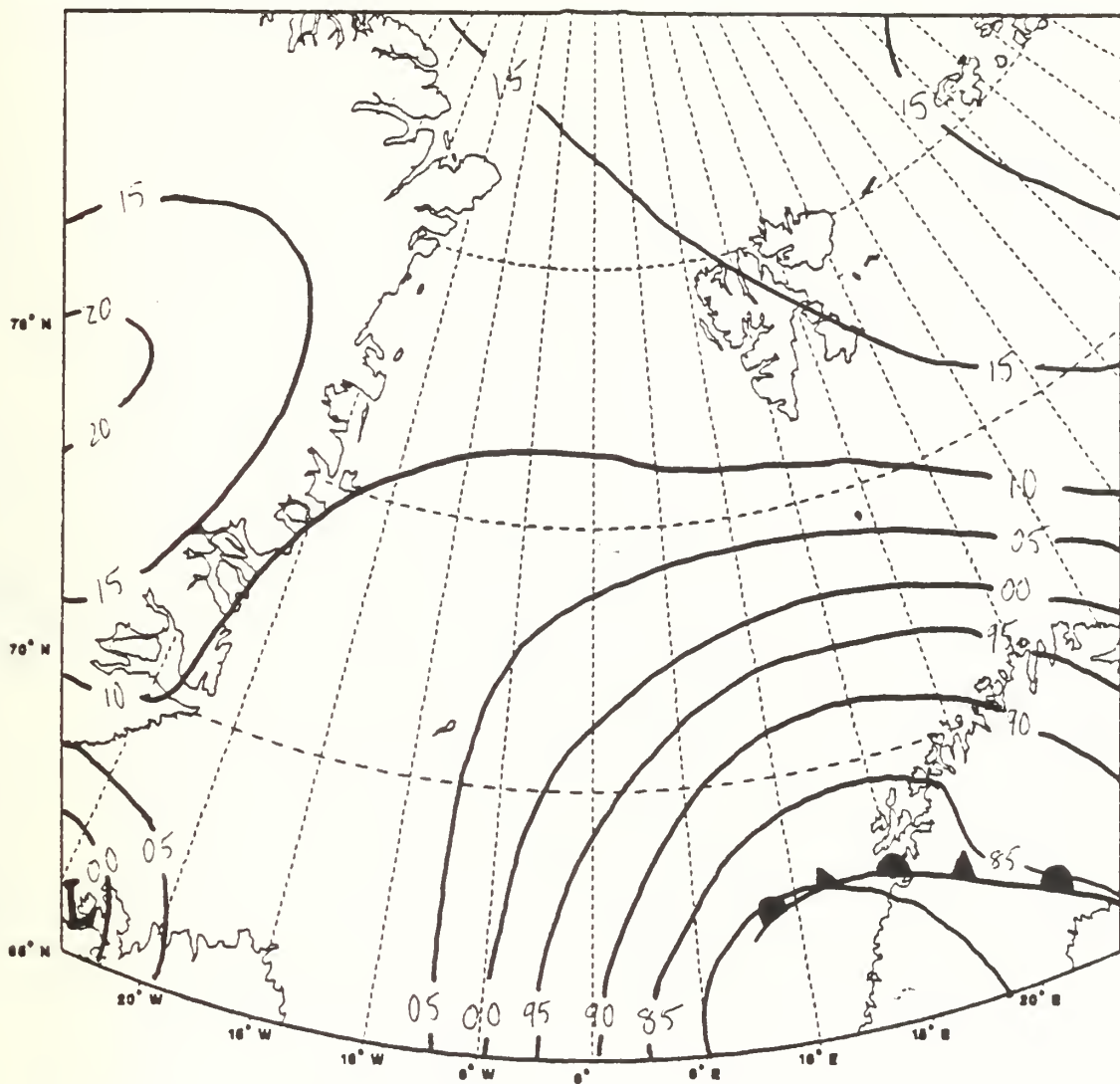


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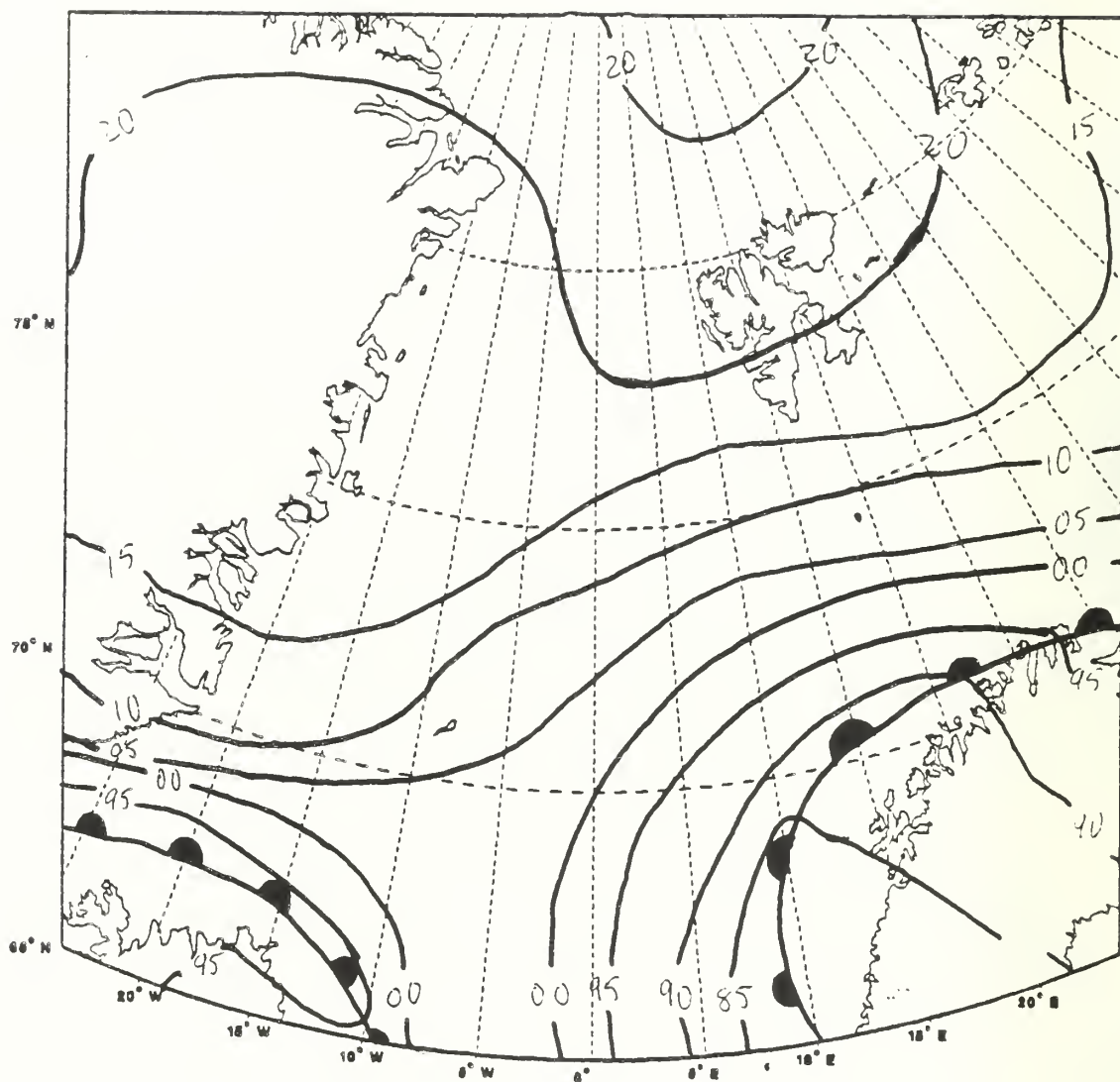




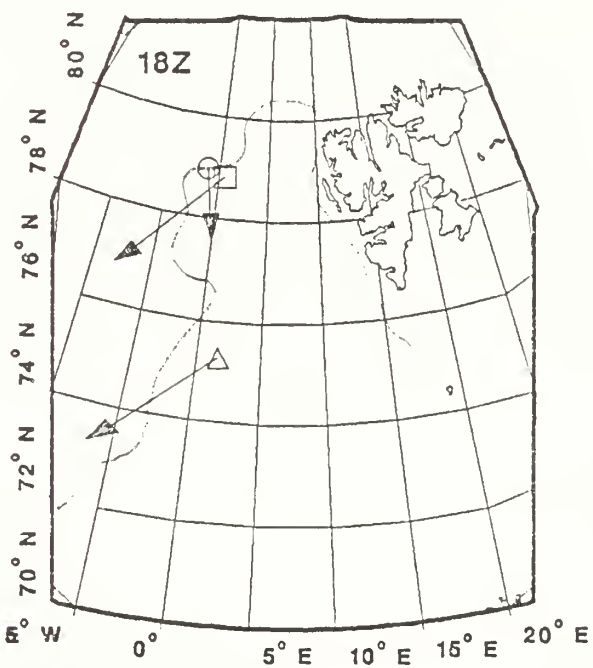
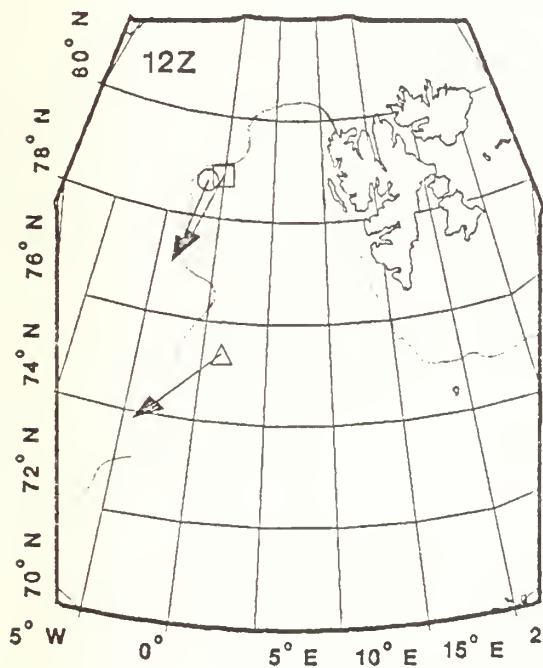
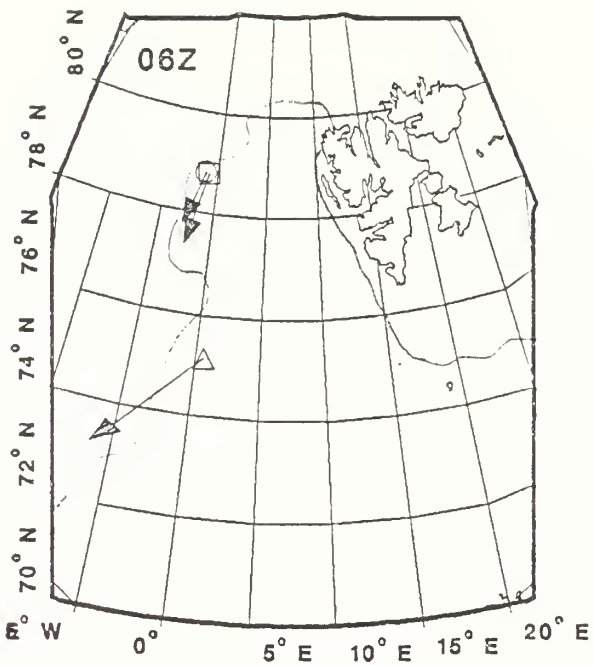
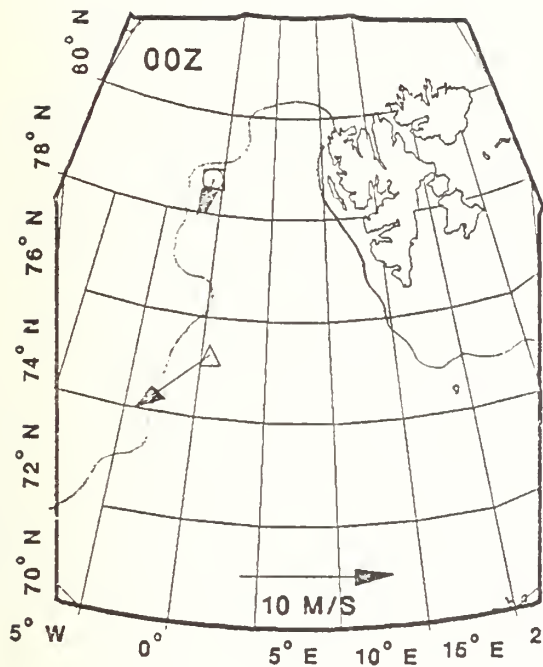




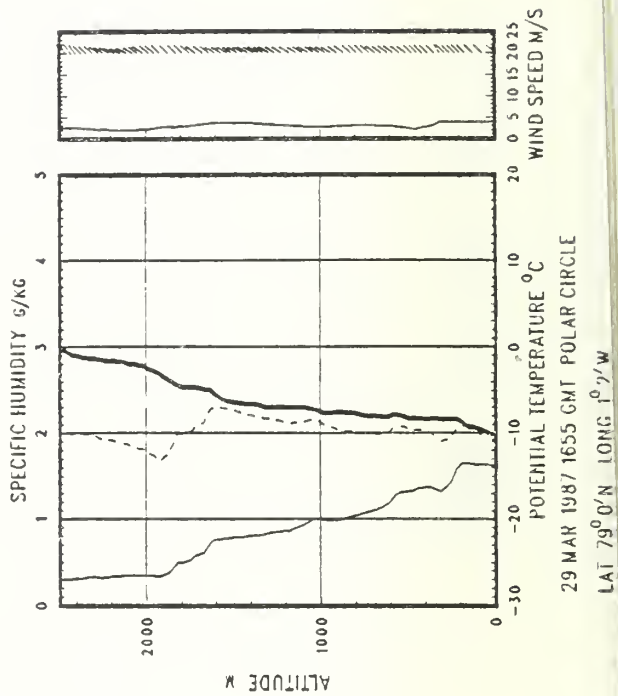
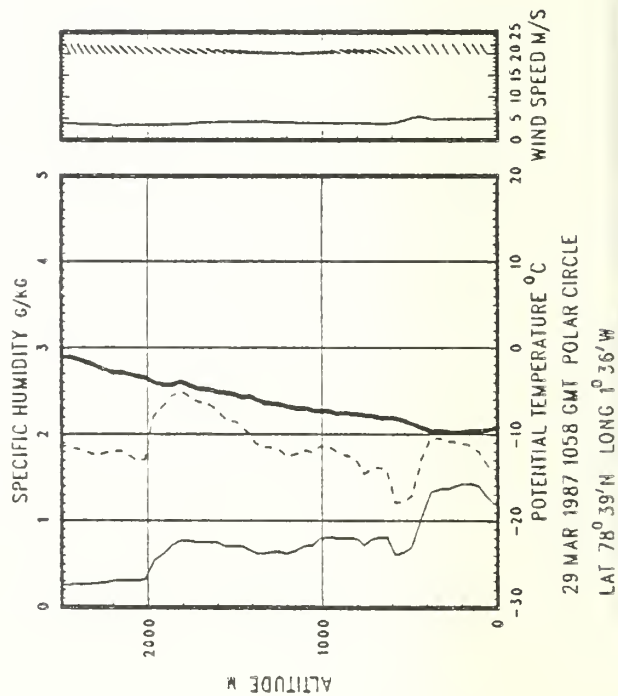
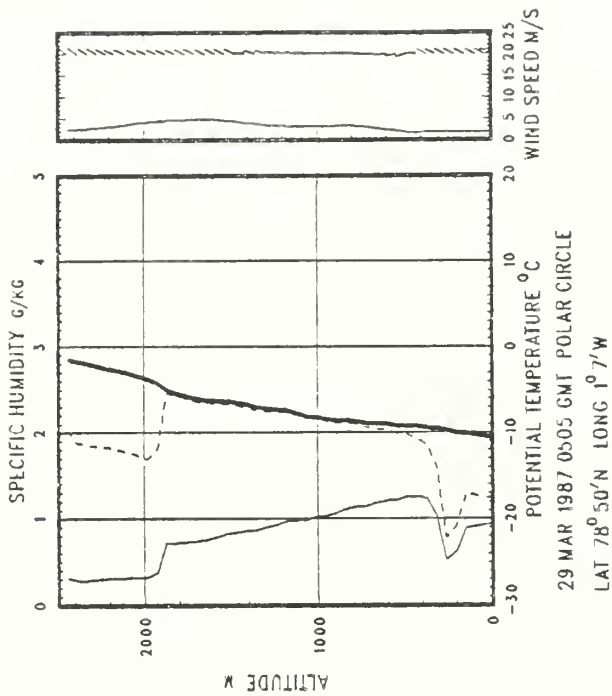
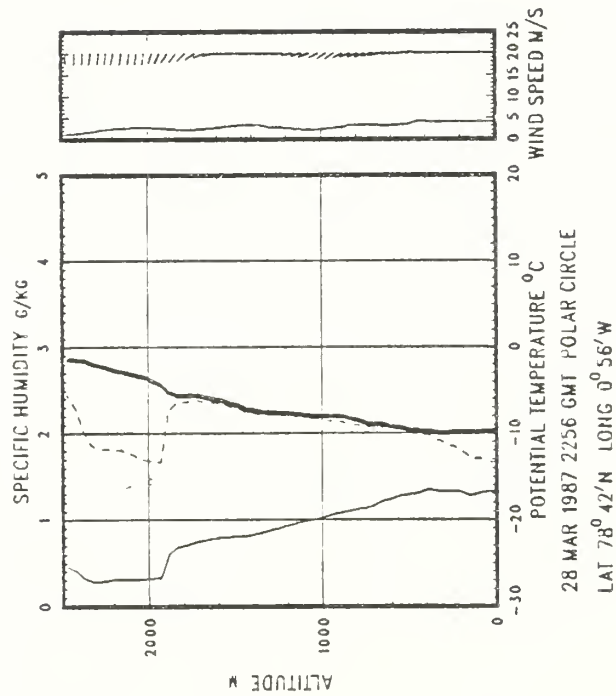
0000 UT 29 March 1987

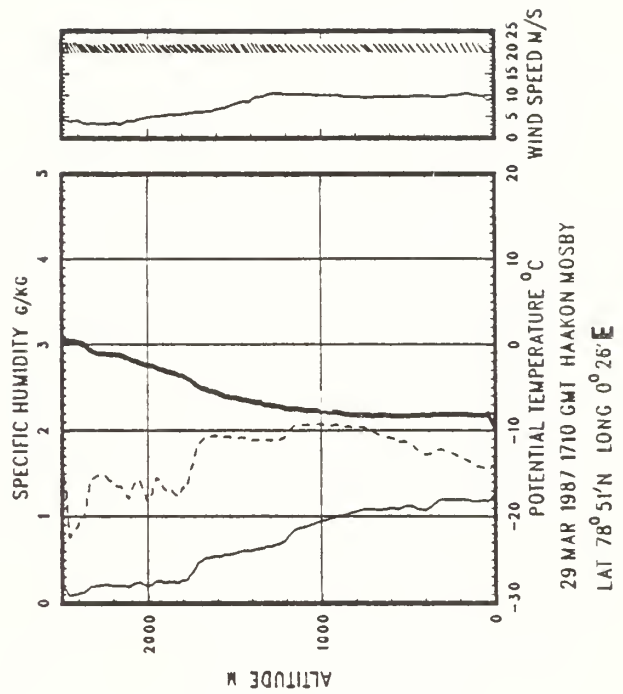
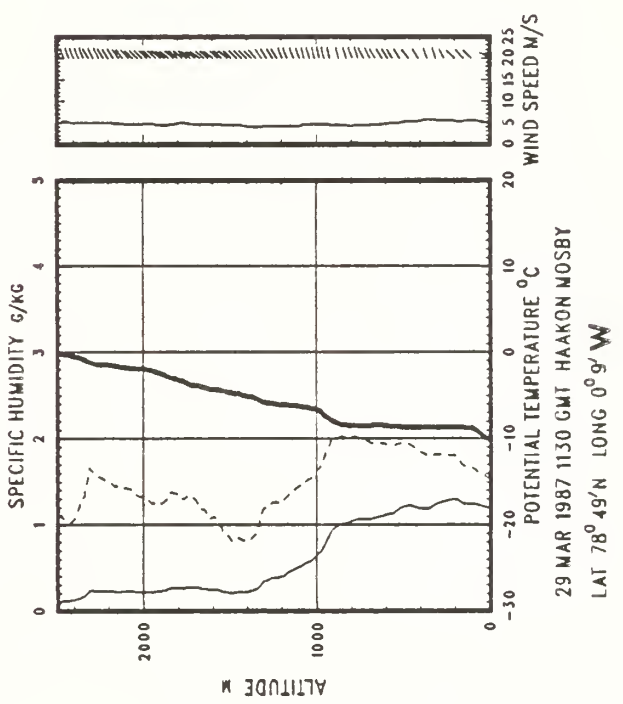
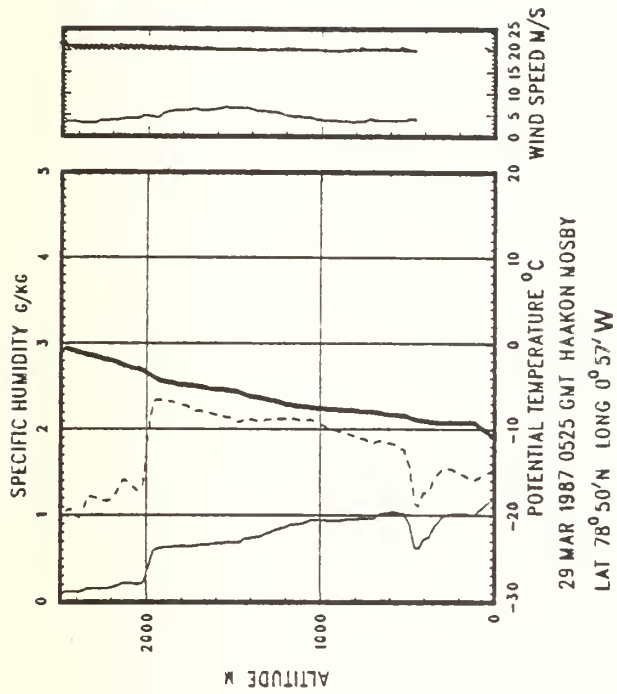


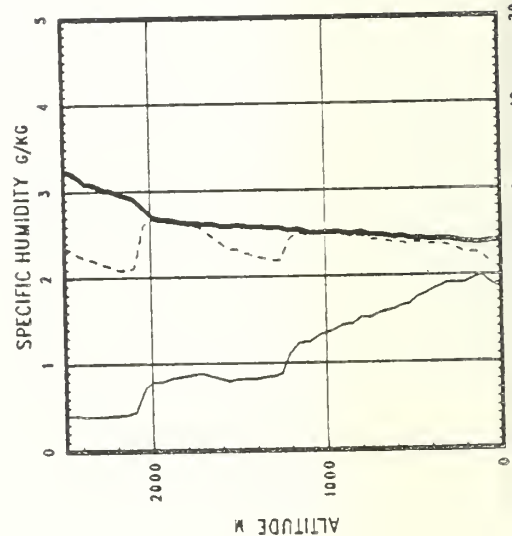
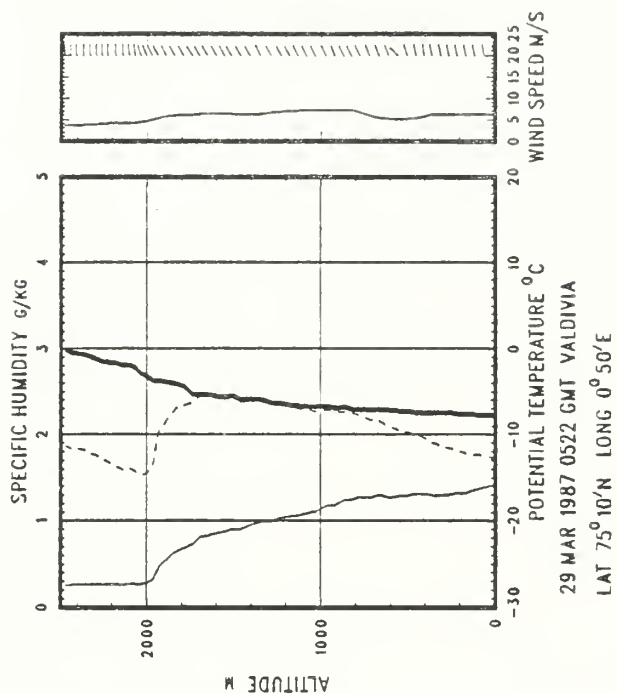
1200 UT 29 March 1987

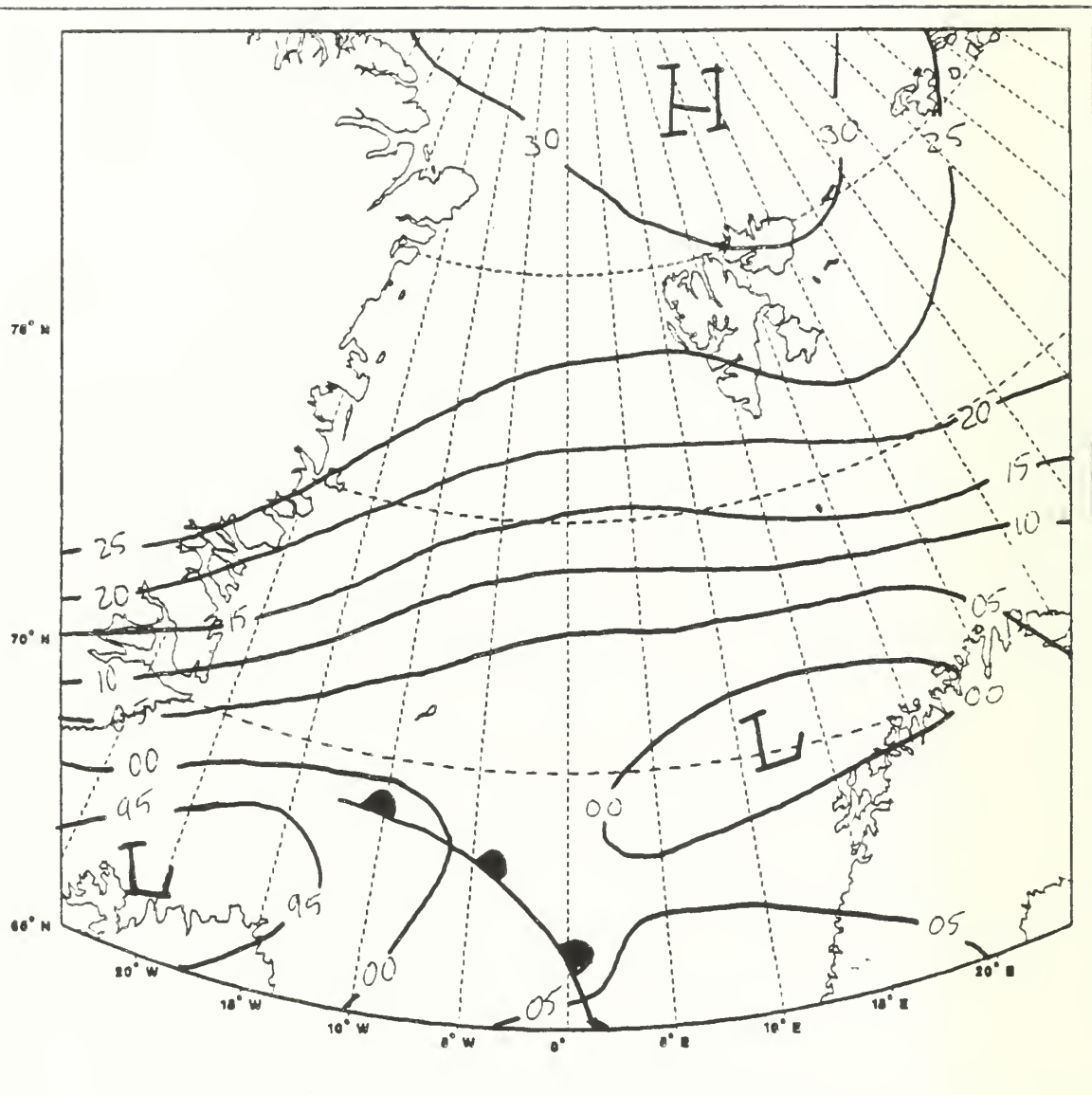


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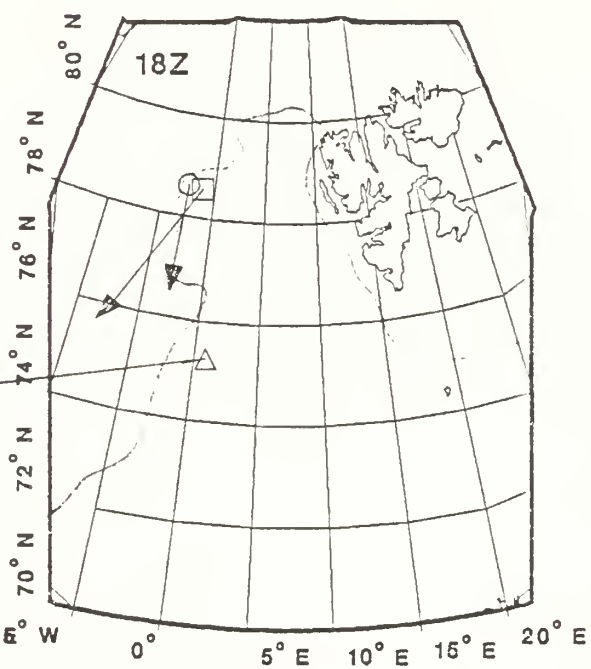
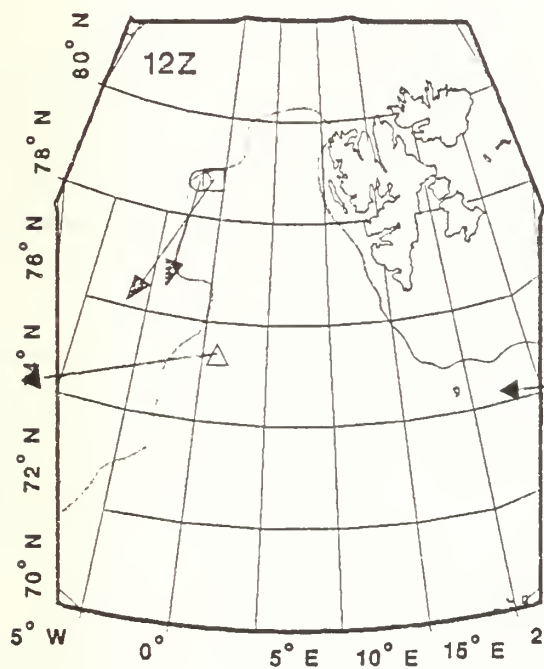
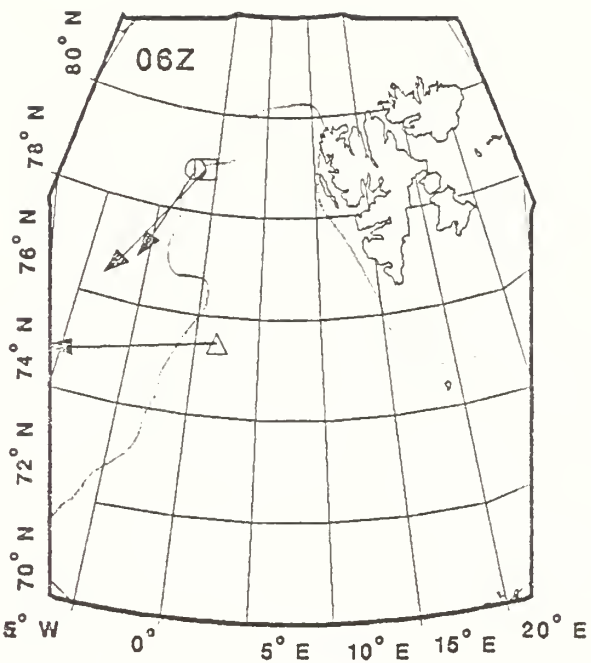
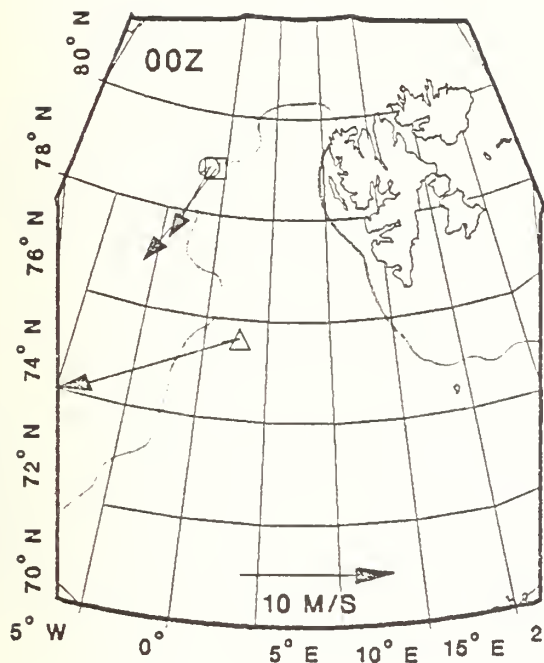




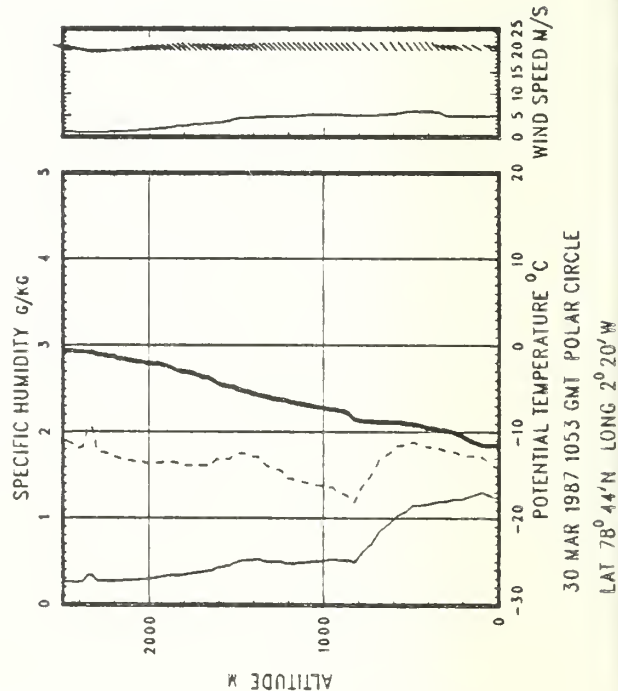
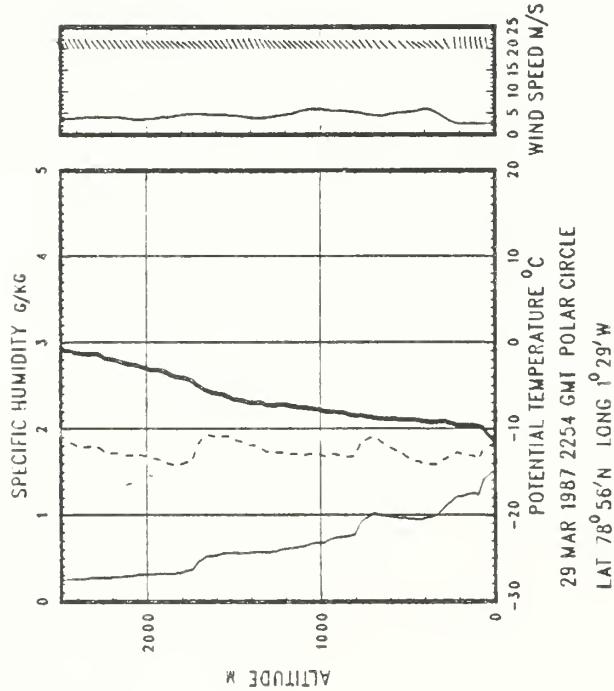
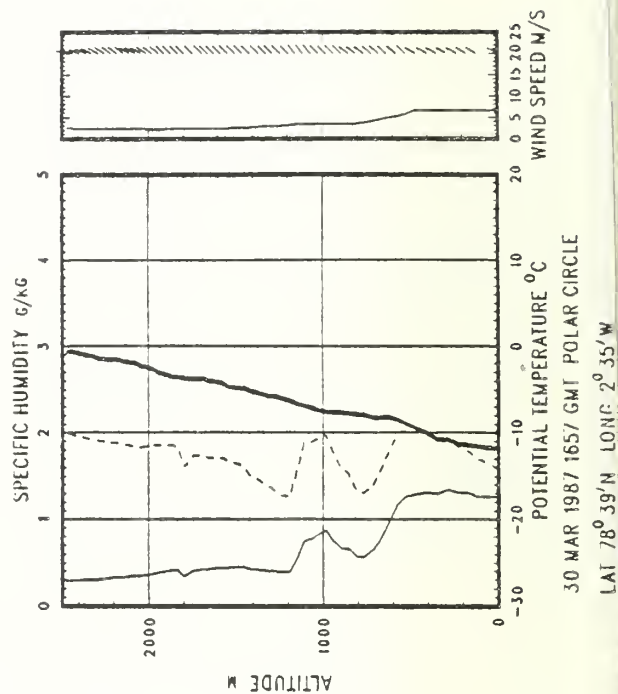
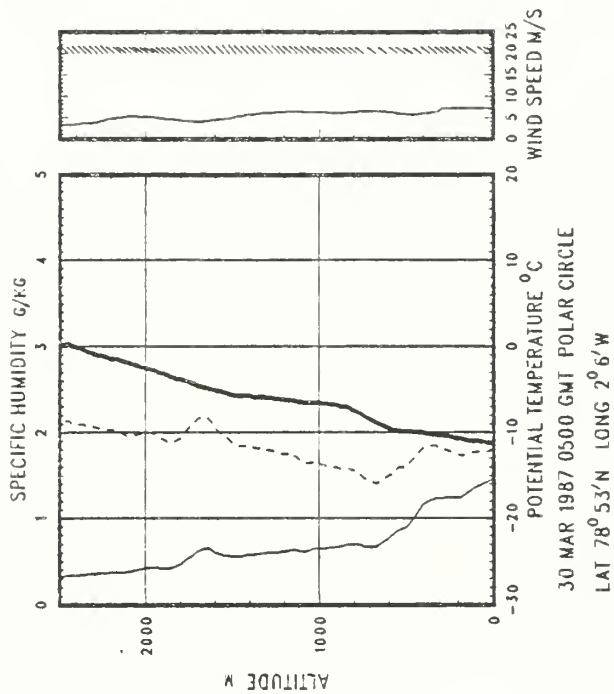


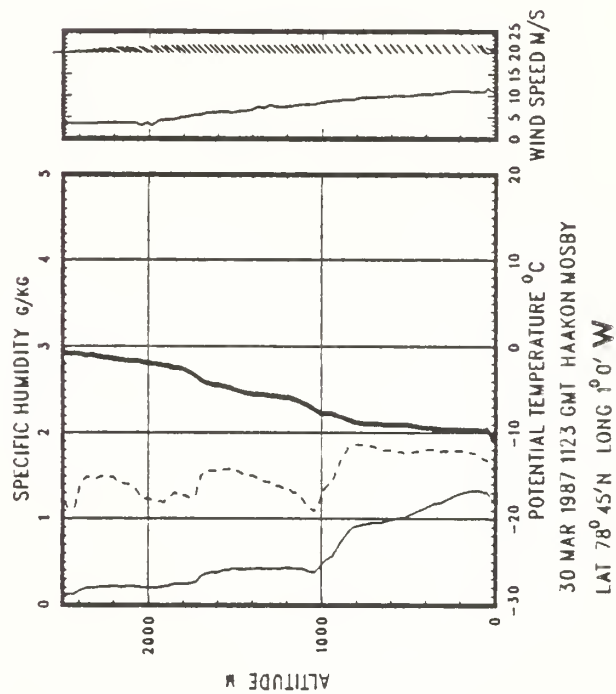
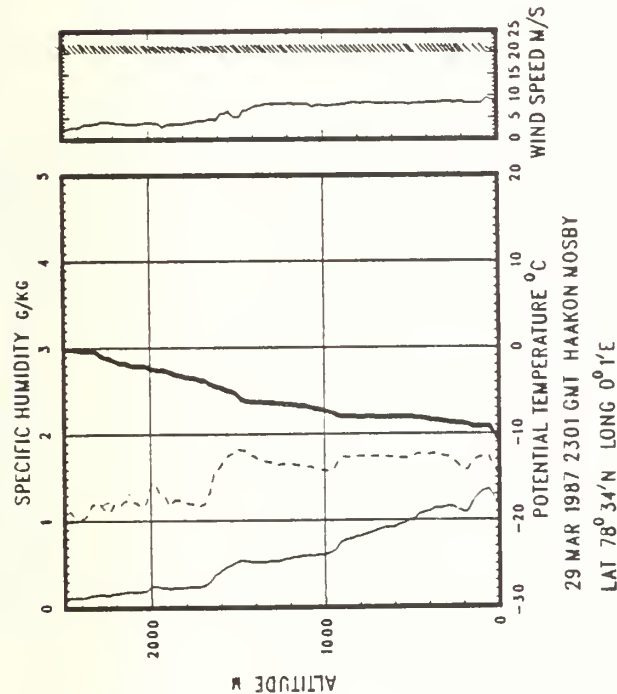
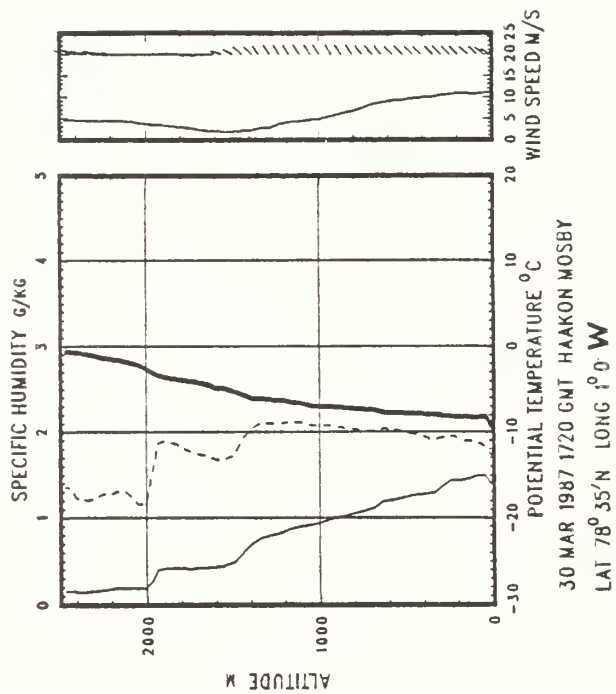
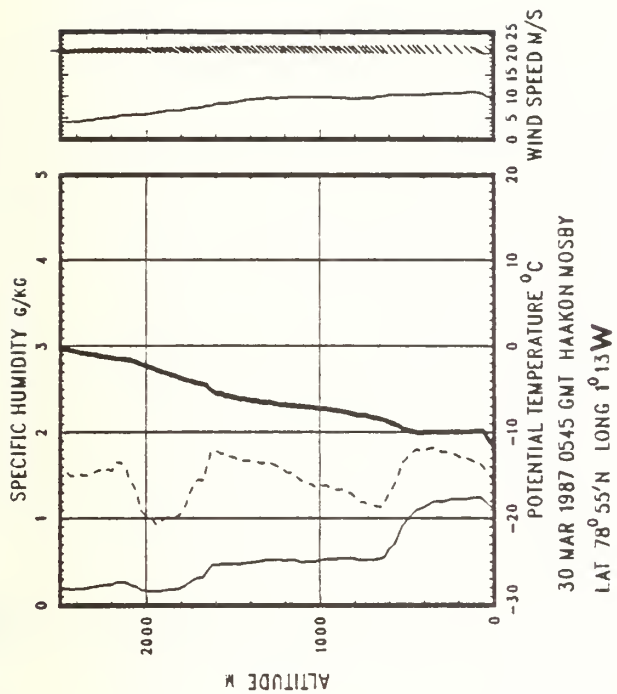


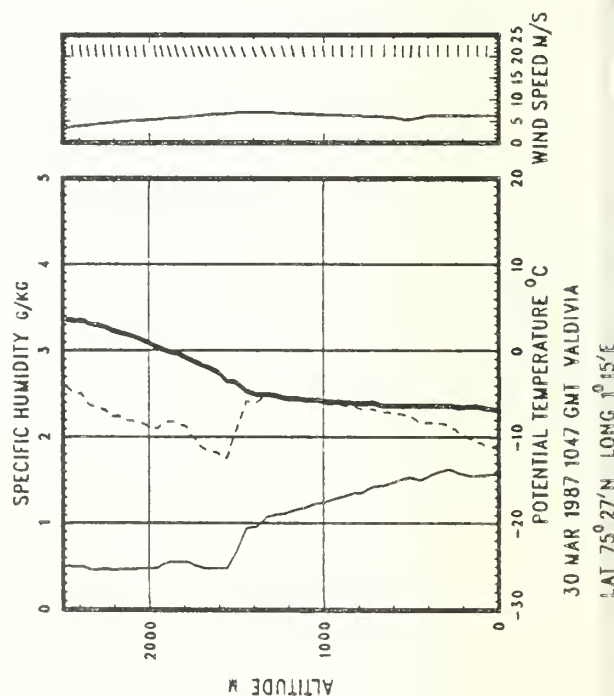
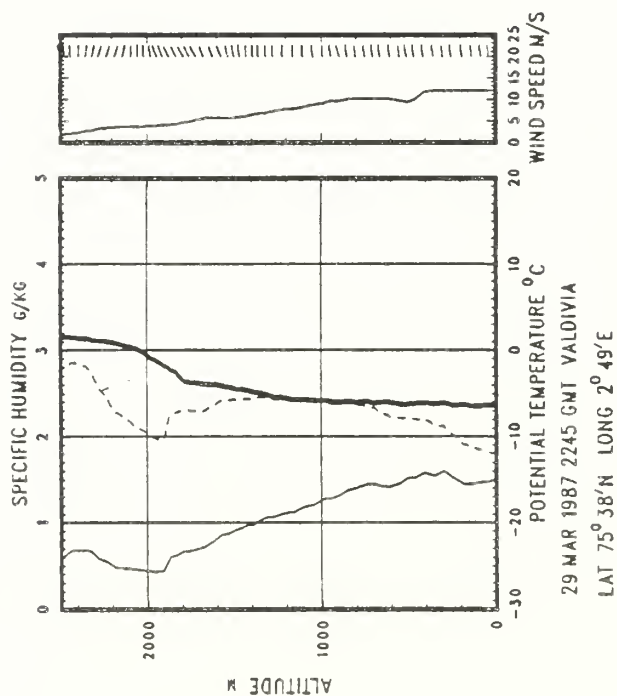
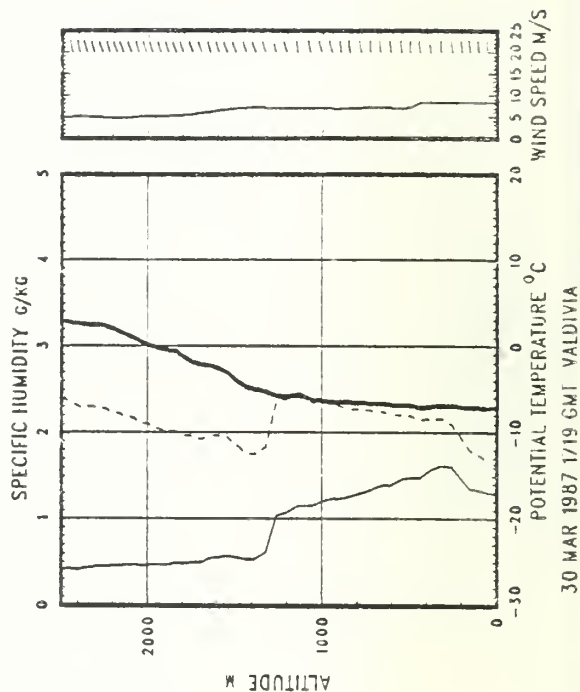
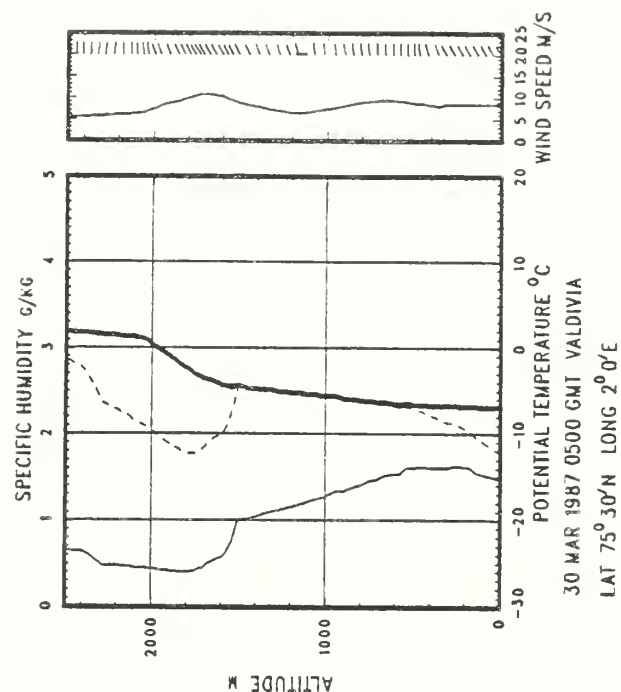
1200 UT 30 March 1987



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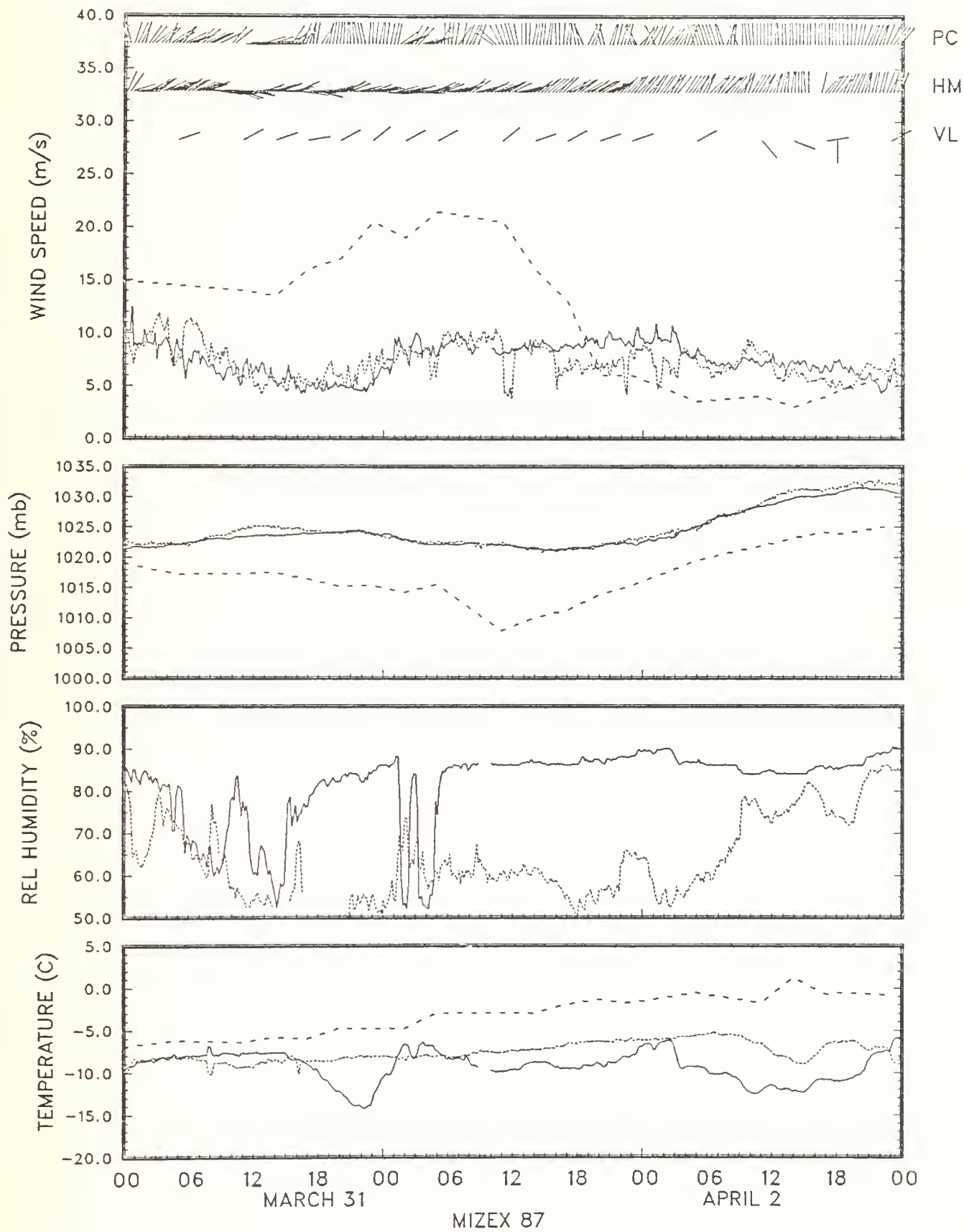


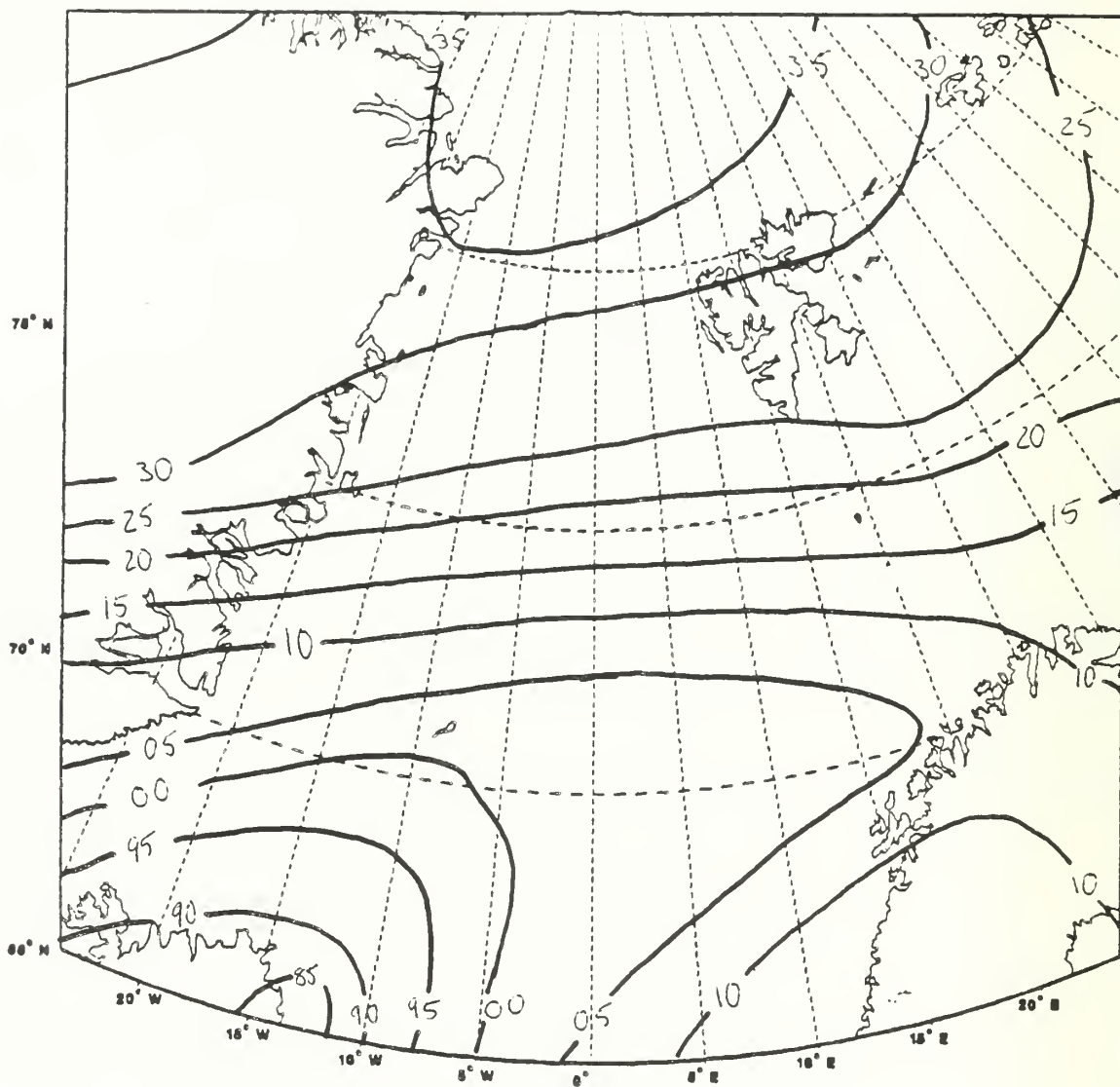


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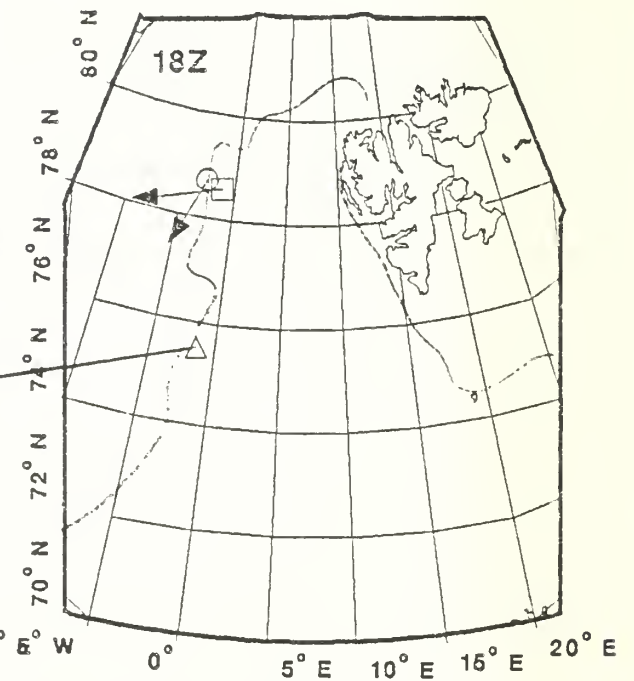
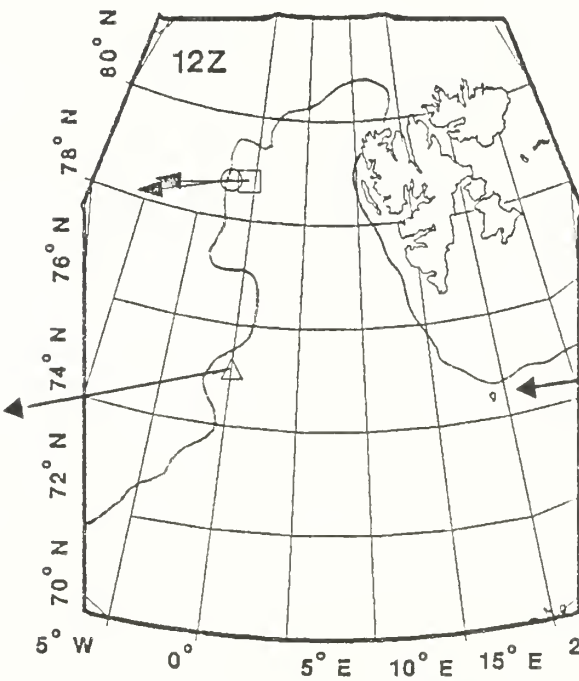
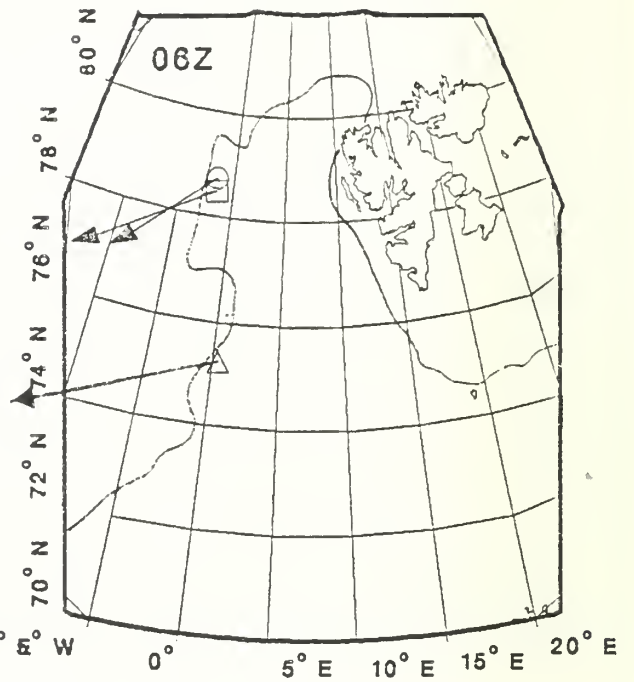
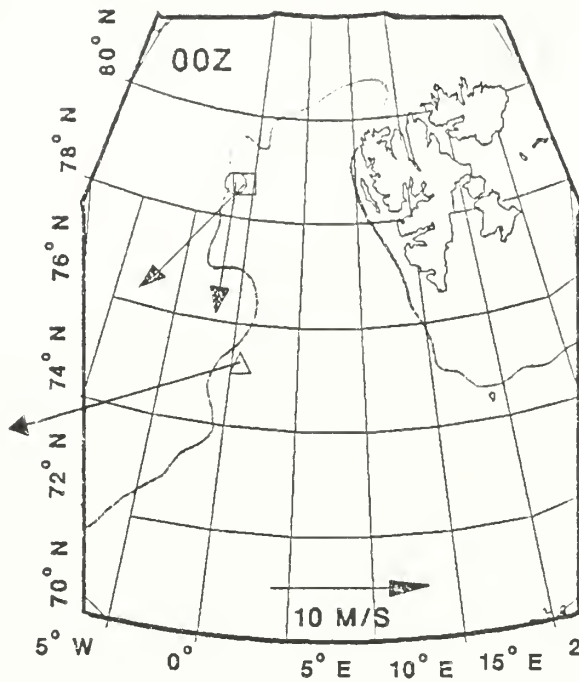
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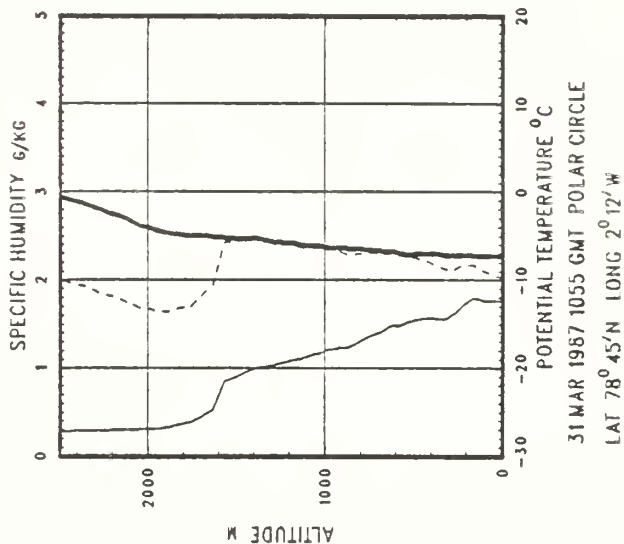
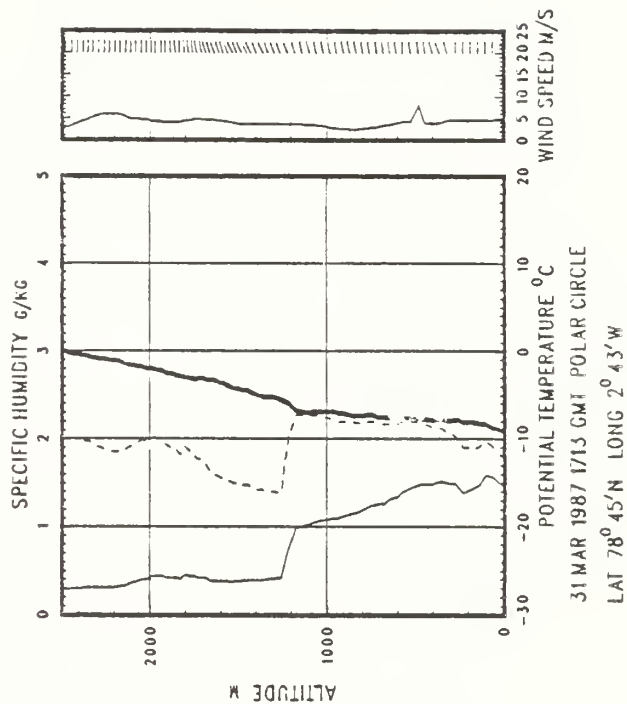
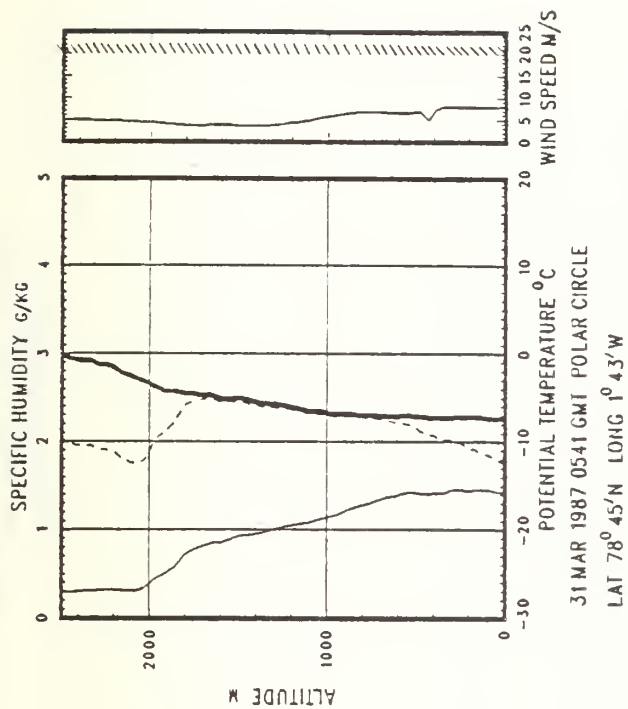


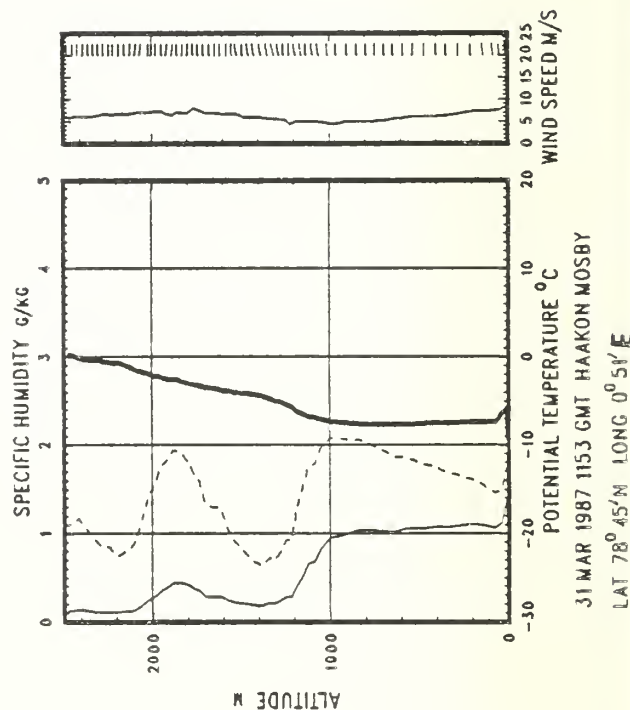
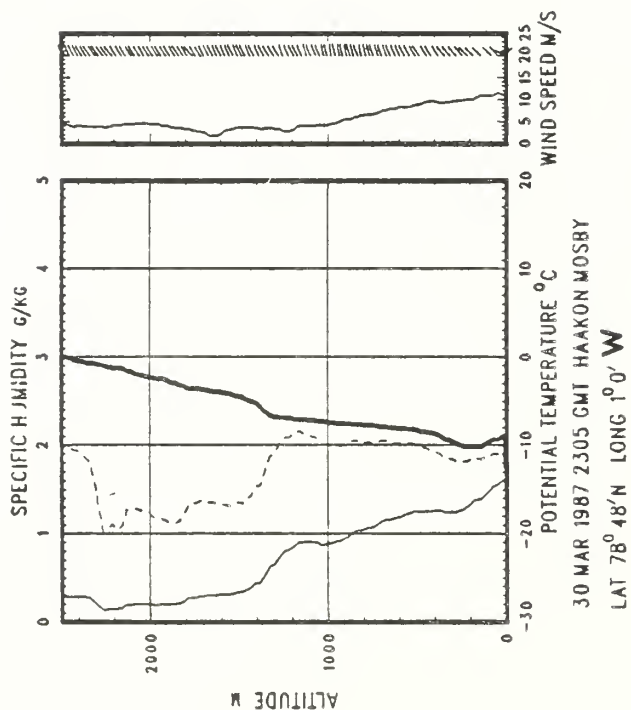
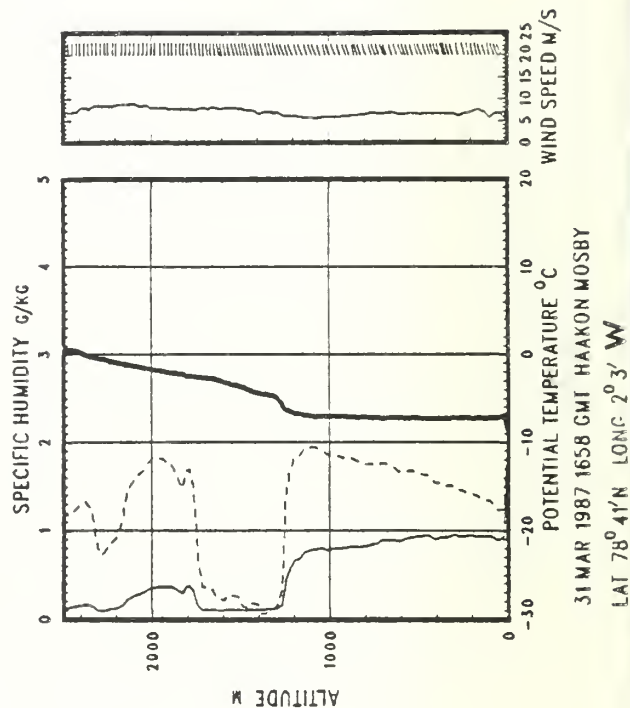
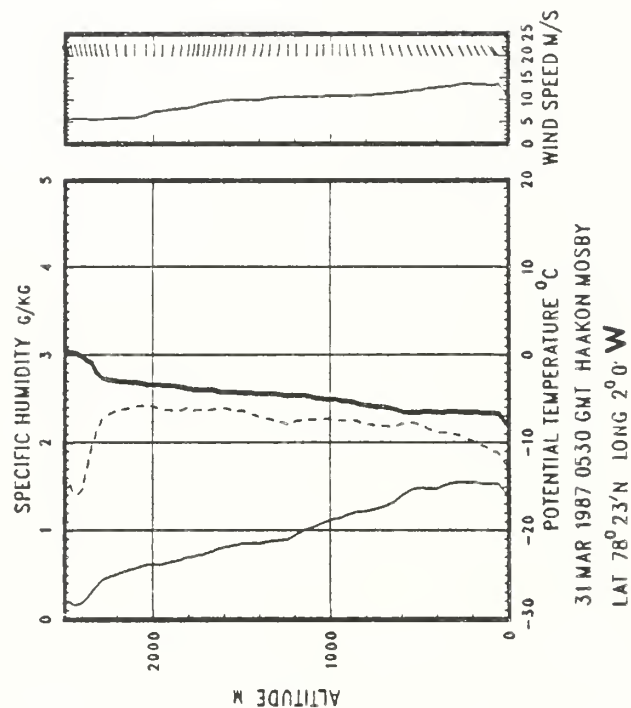


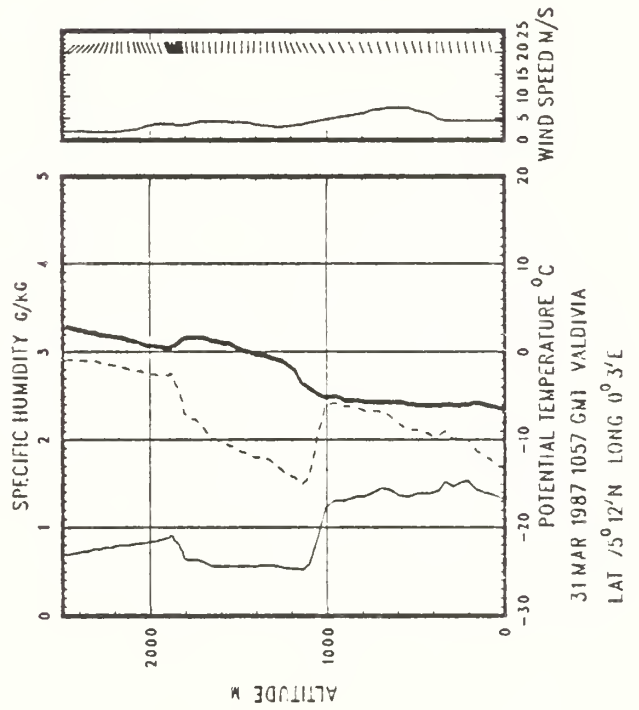
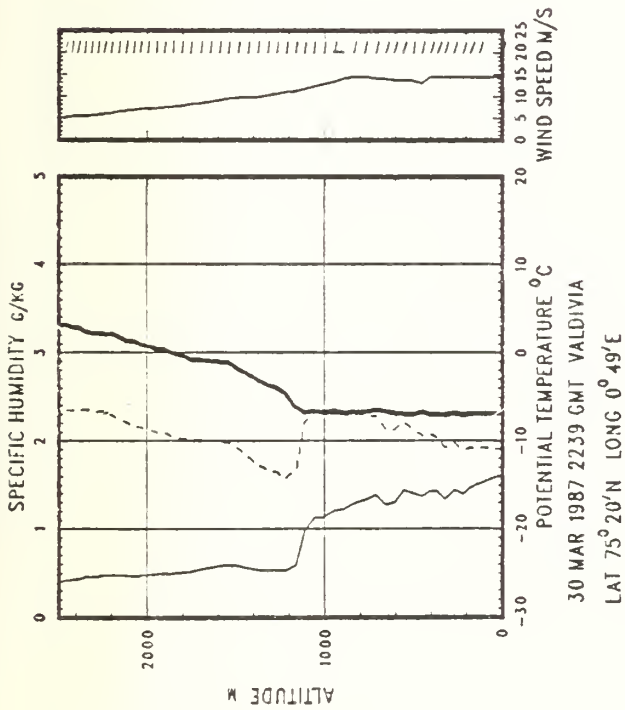
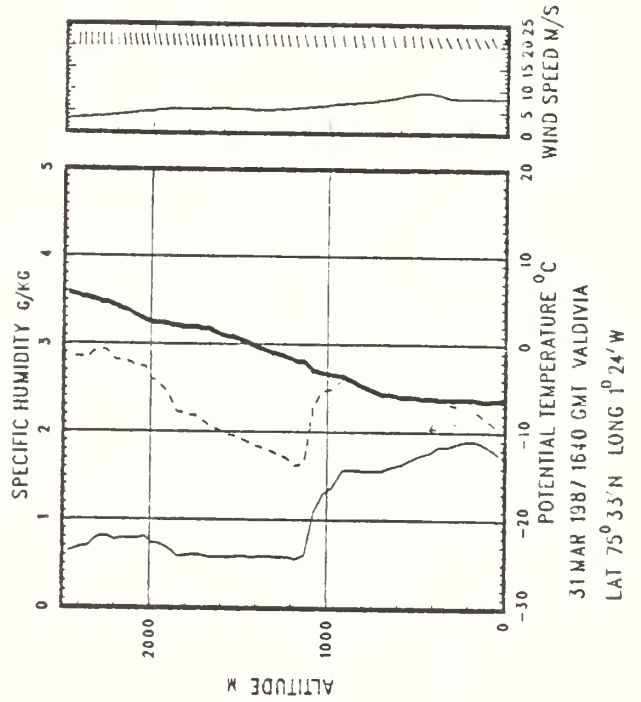
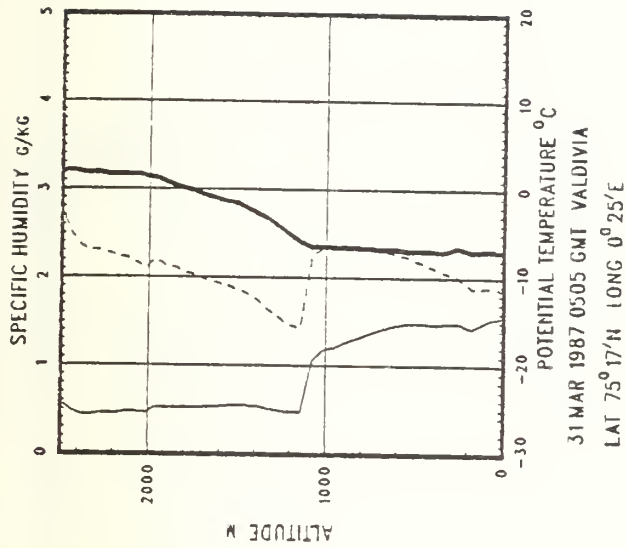
0000 UT 31 March 1987

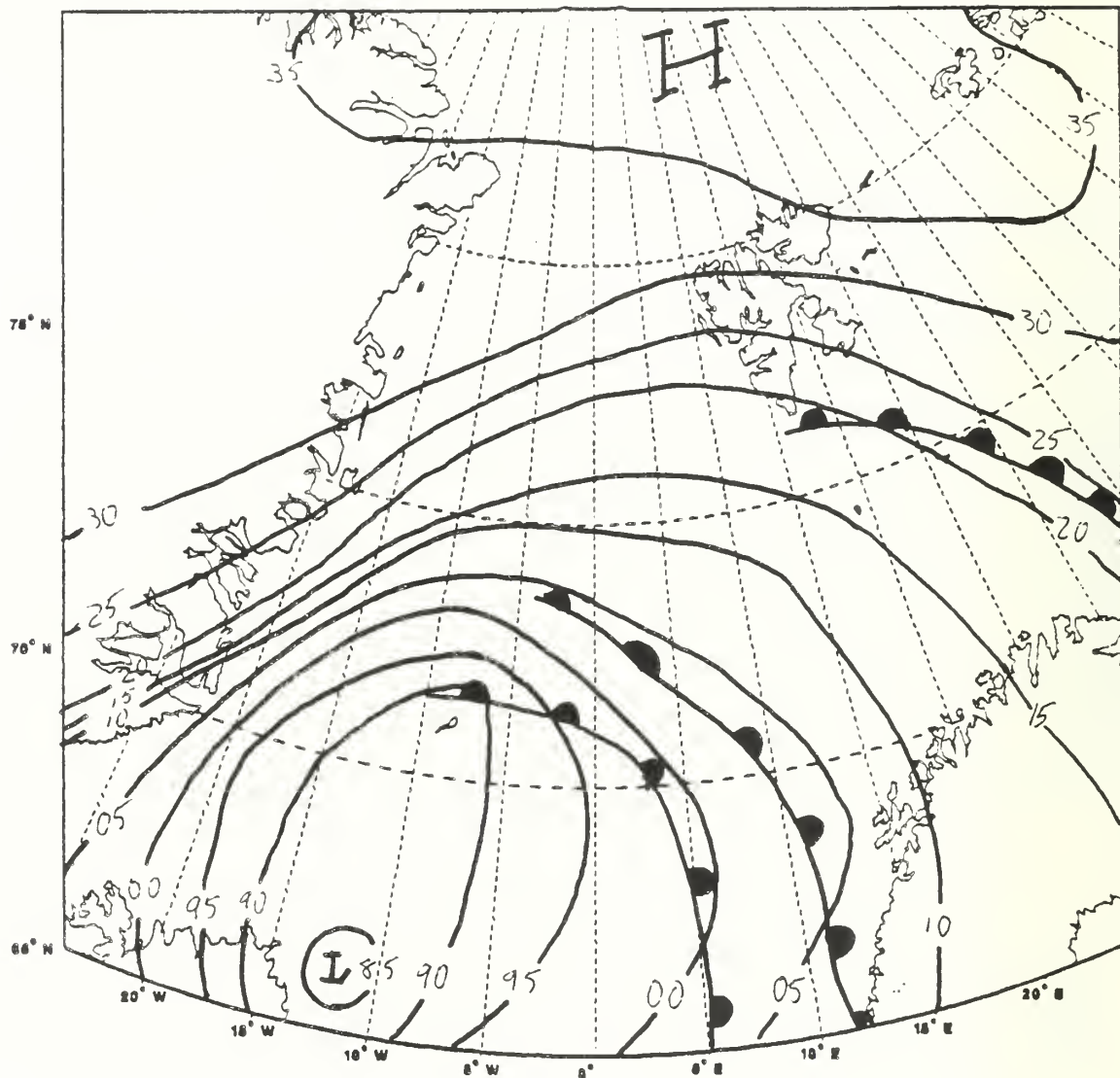


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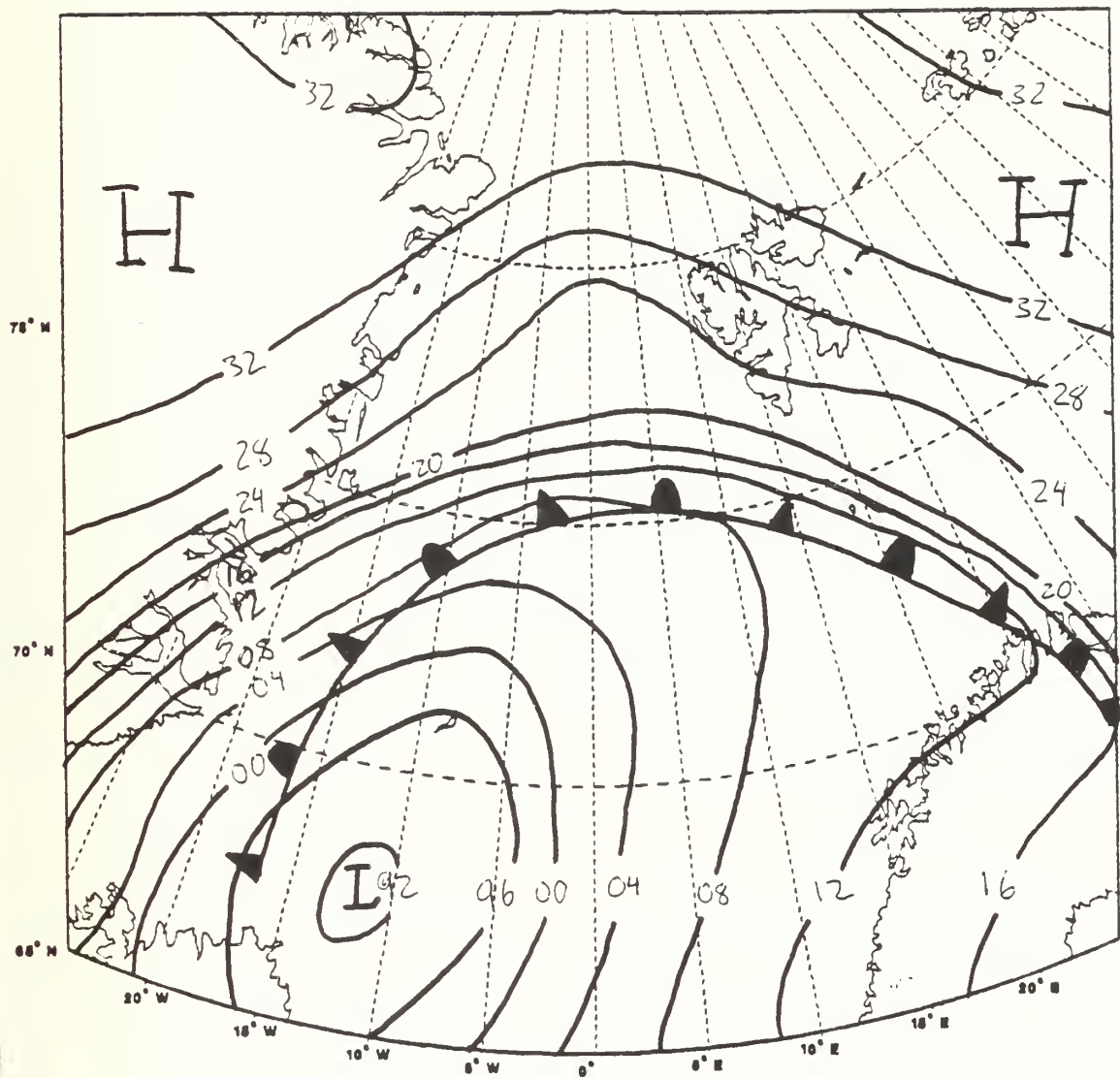




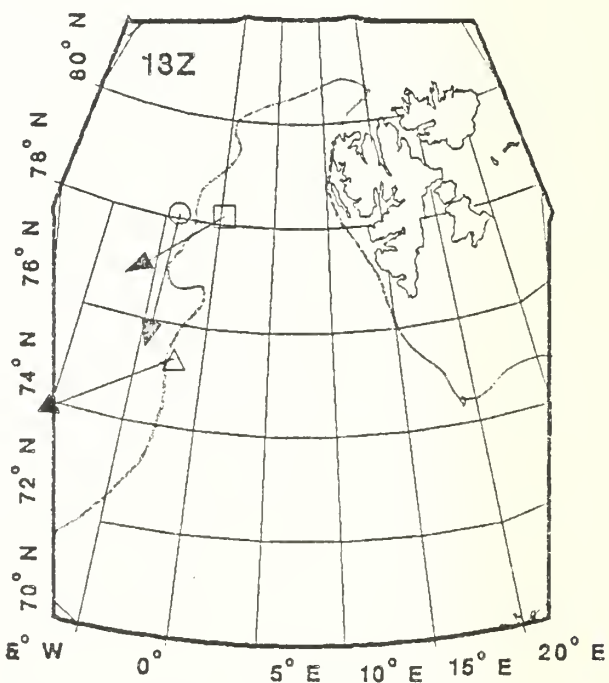
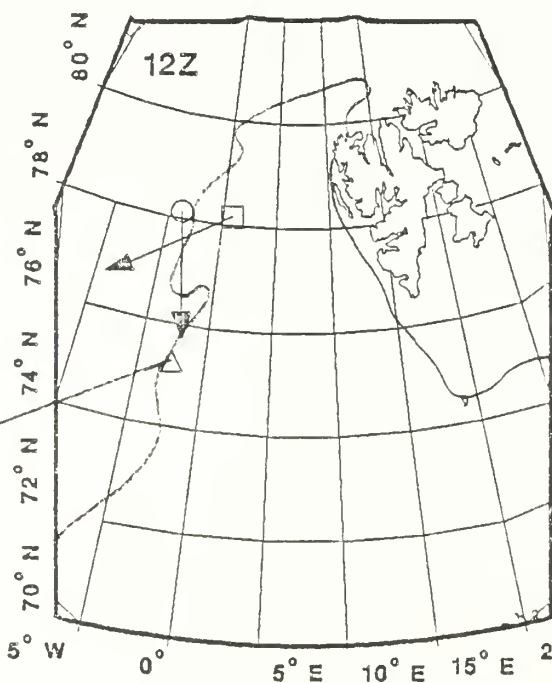
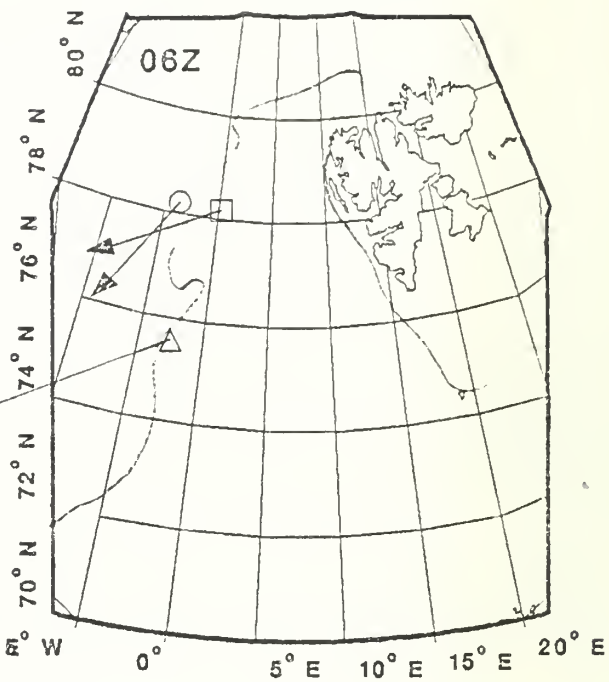
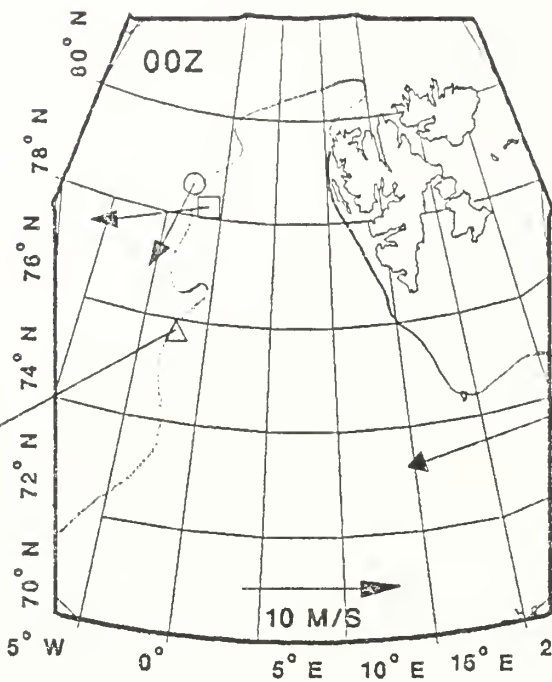




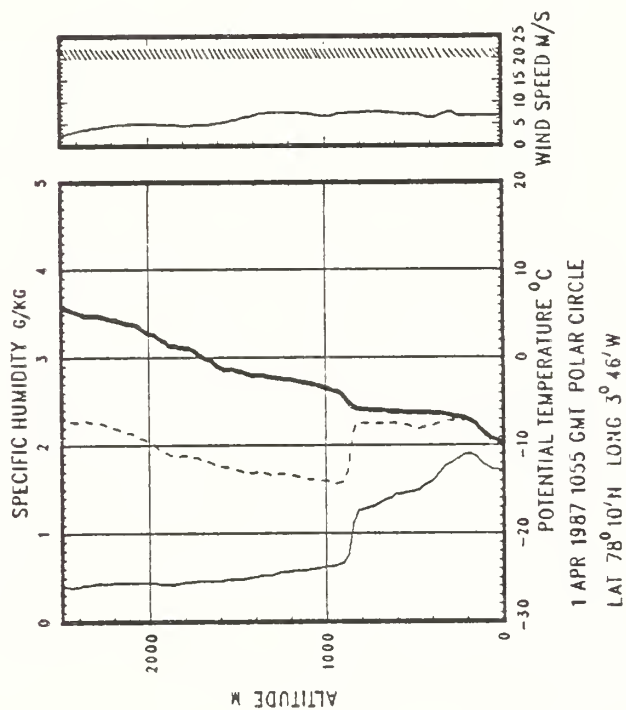
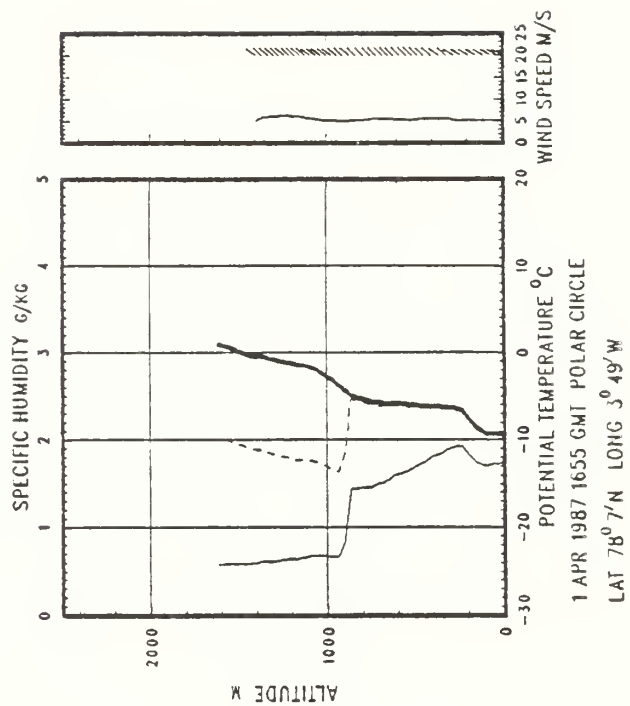
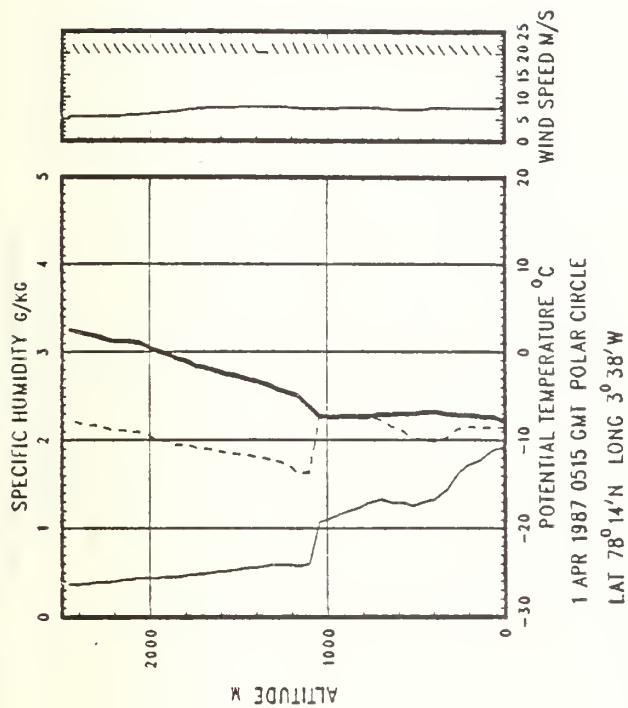
0000 UT 1 April 1987

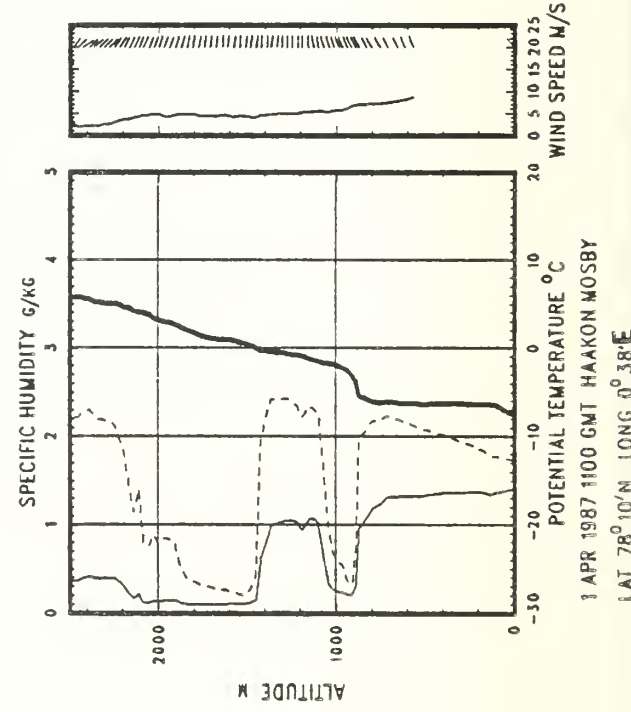
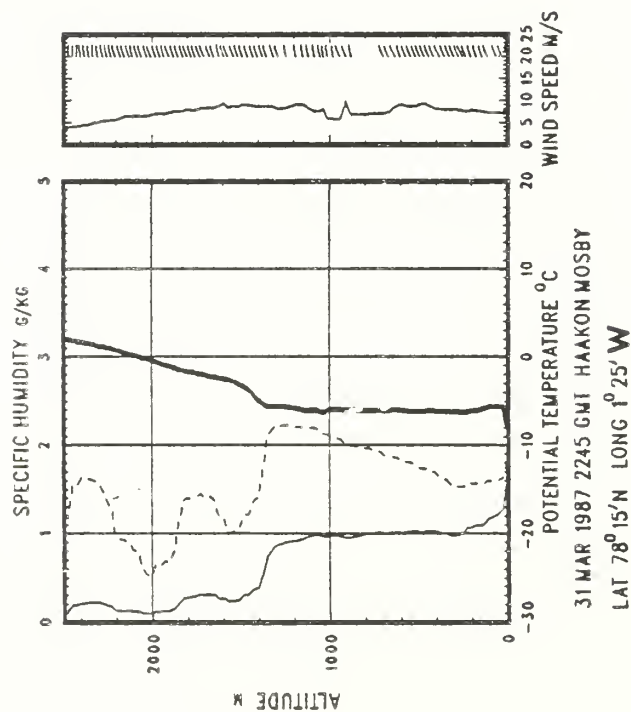
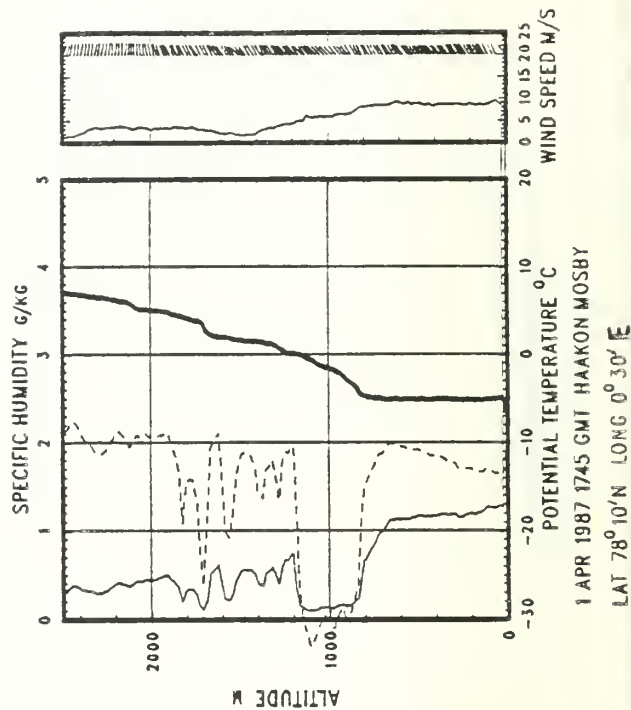
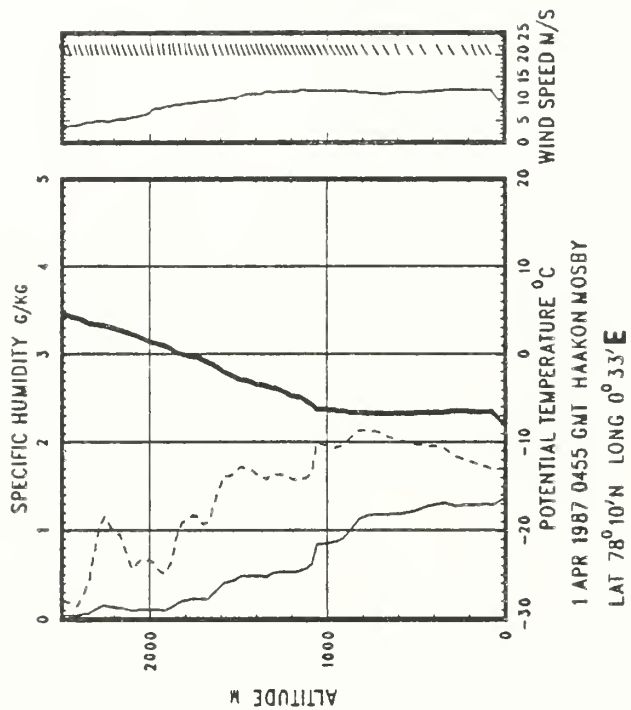


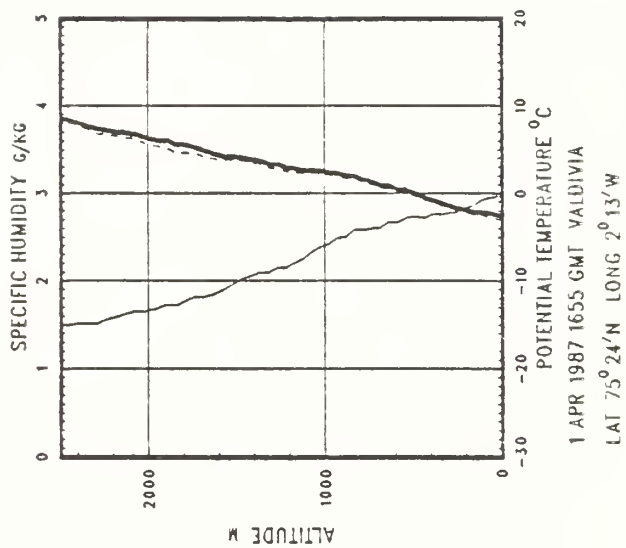
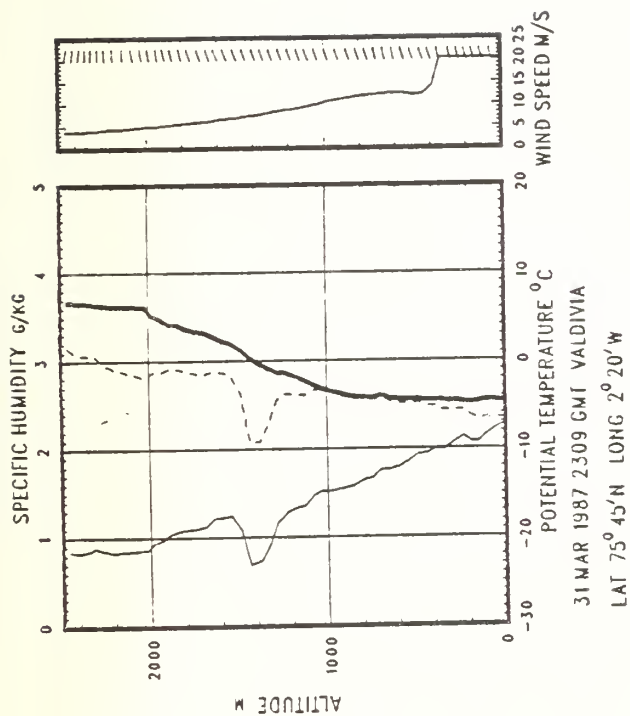
1200 UT 1 April 1987

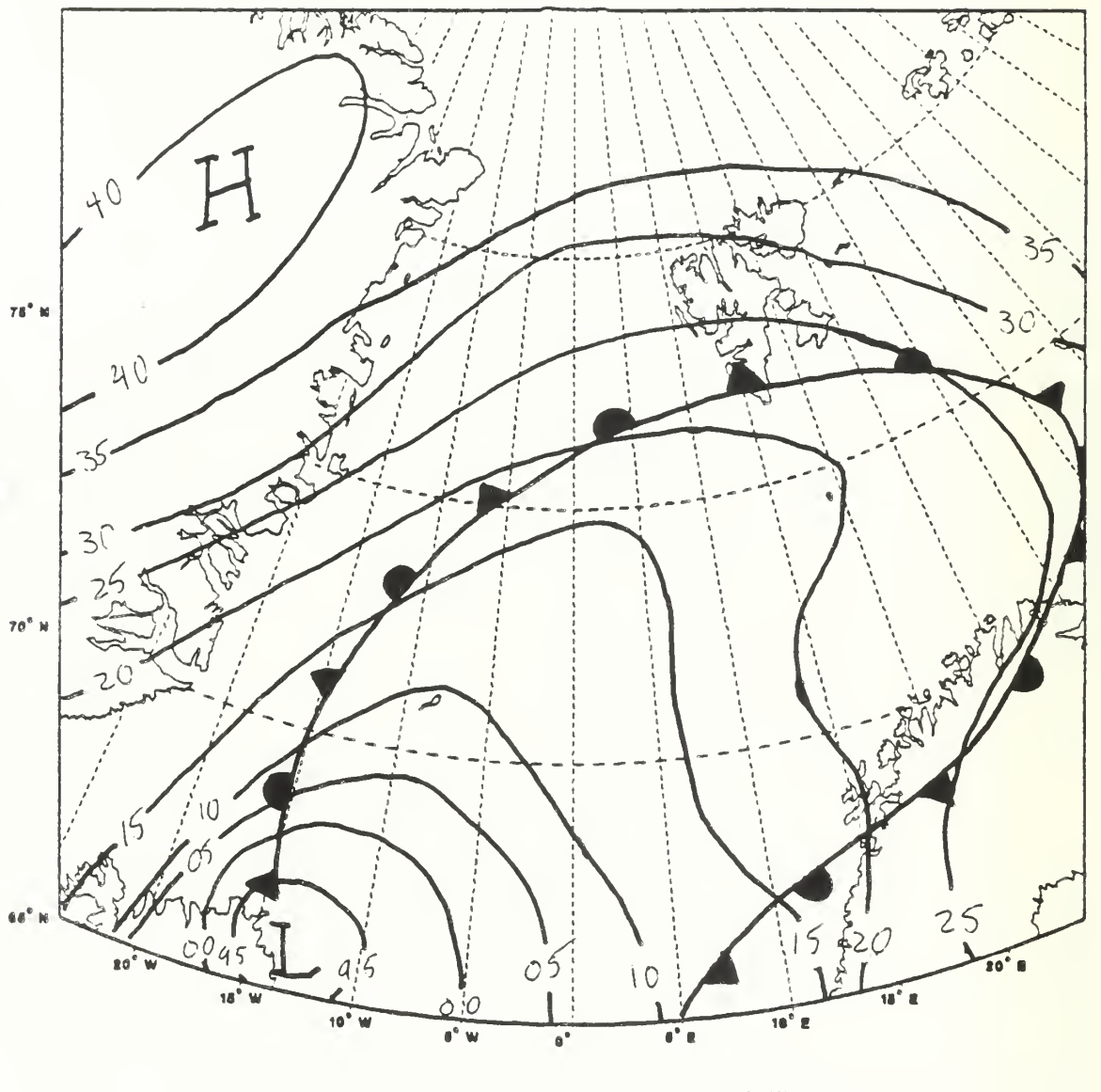


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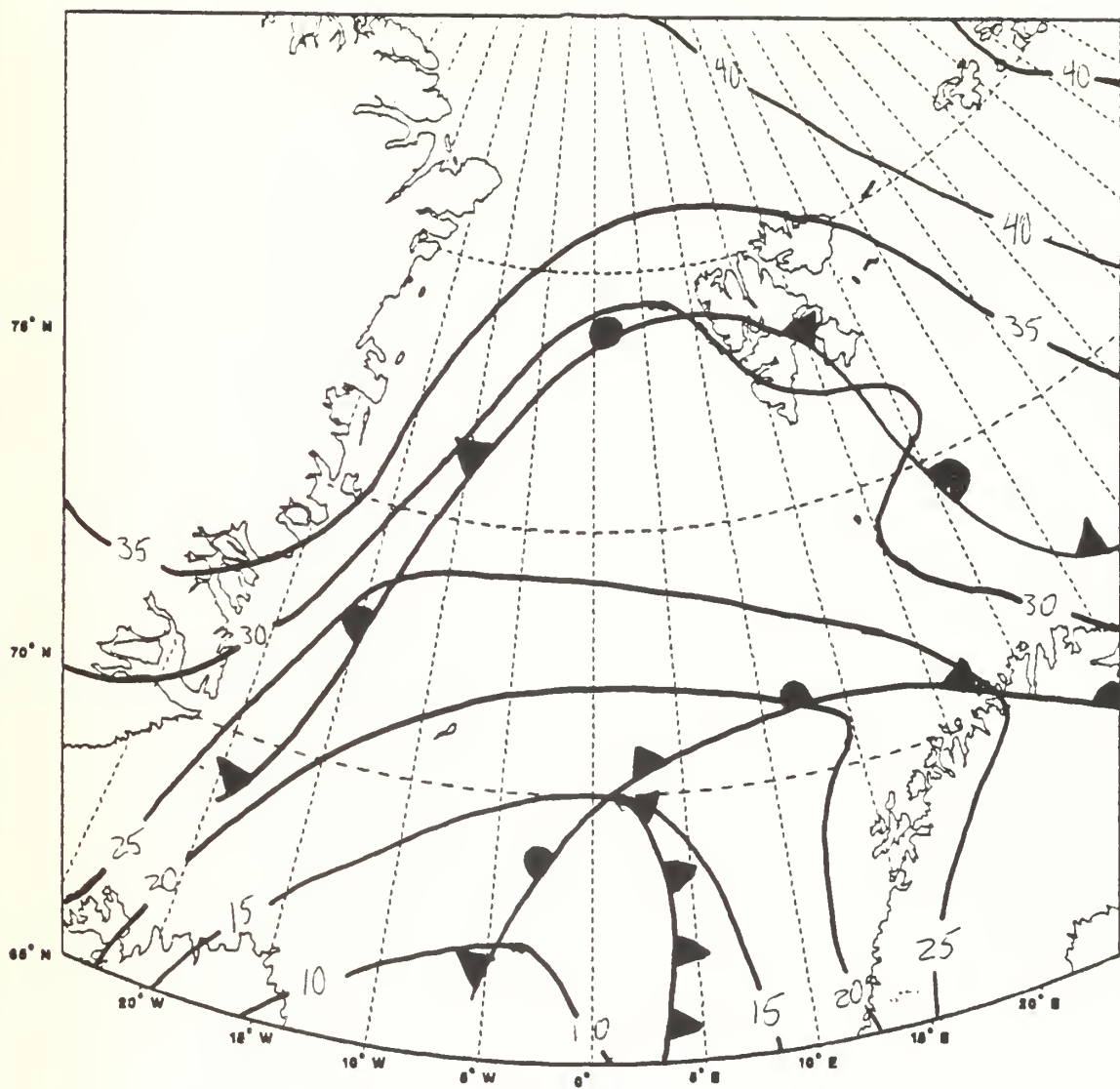




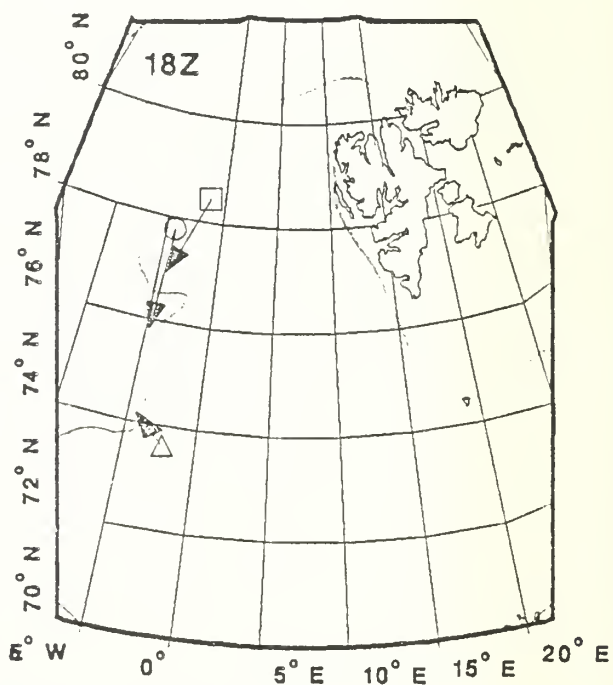
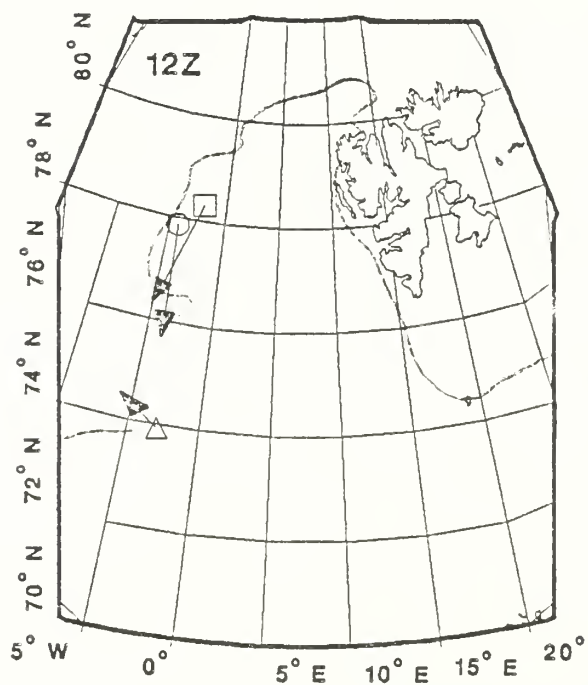
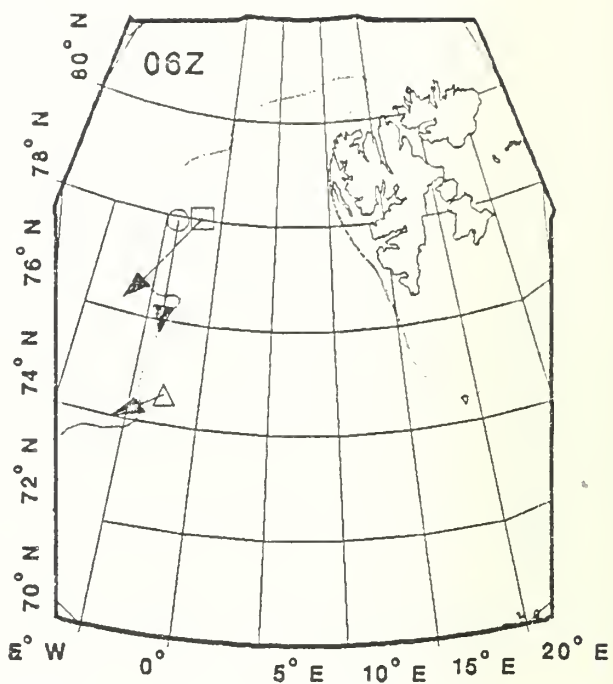
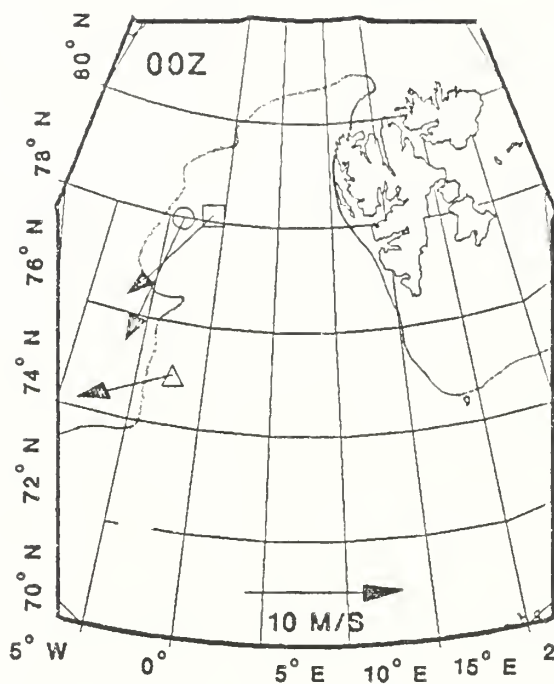




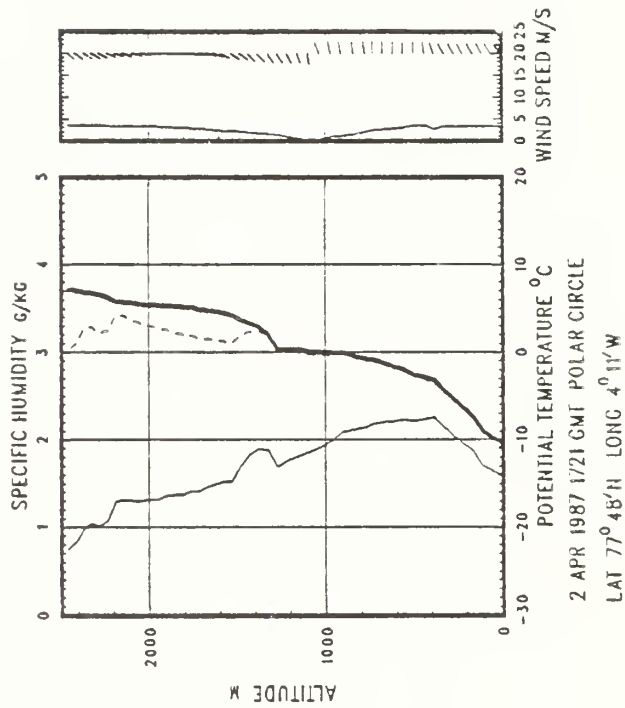
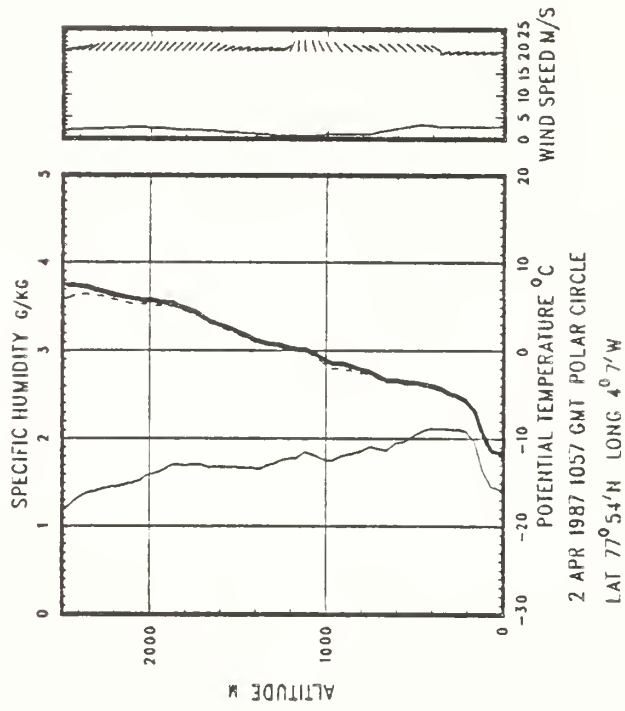
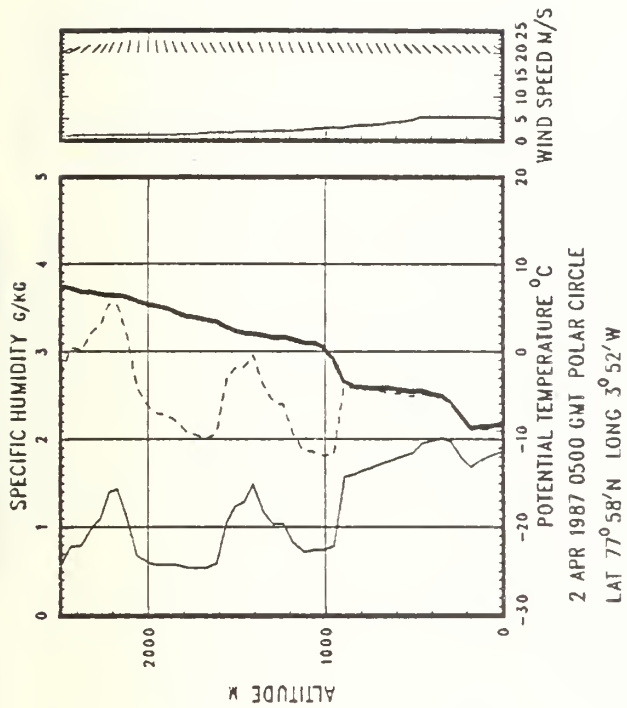
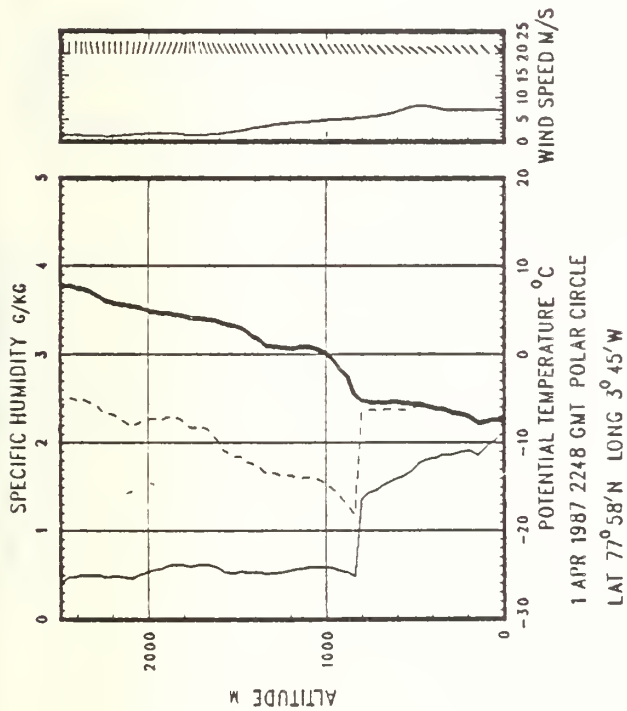
0000 UT 2 April 1987

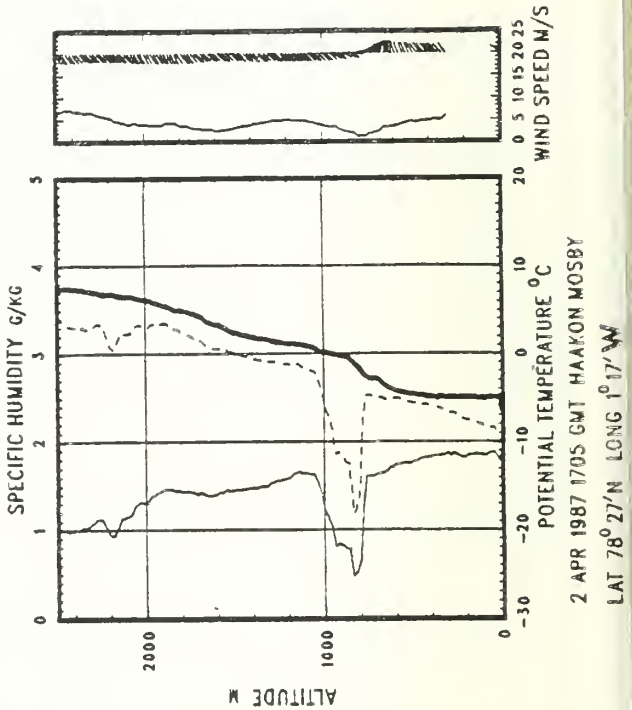
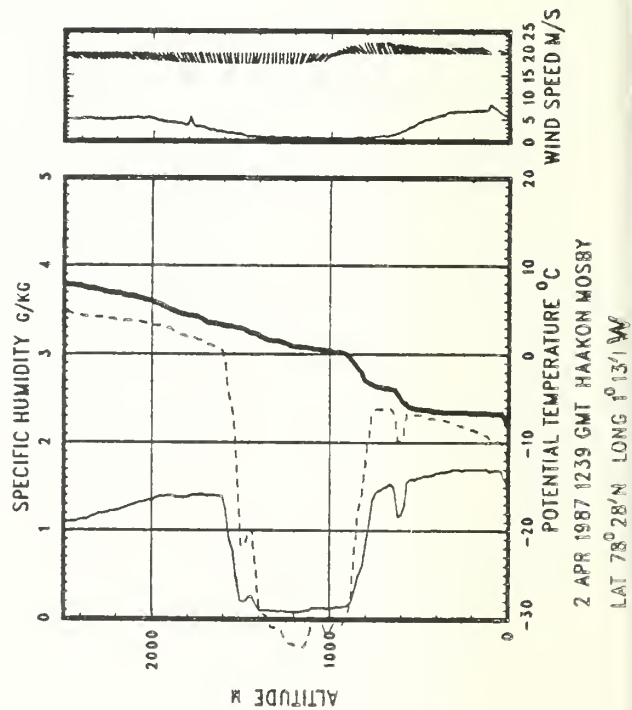
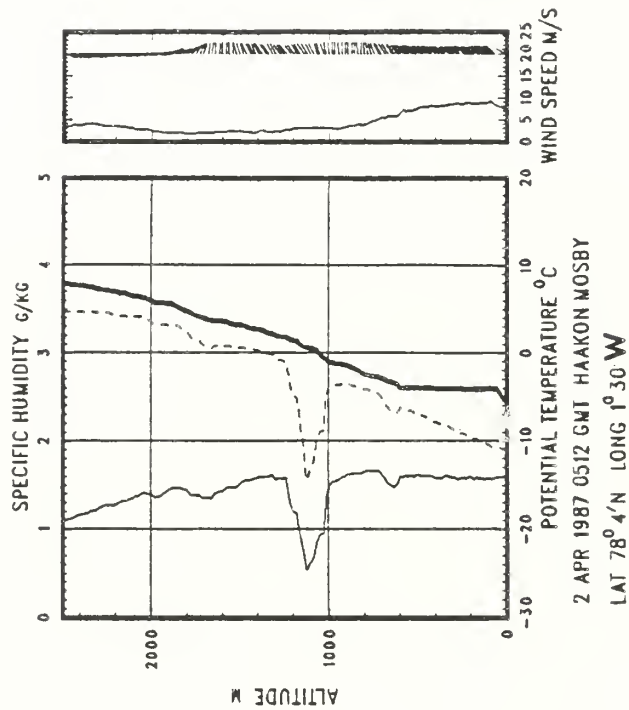
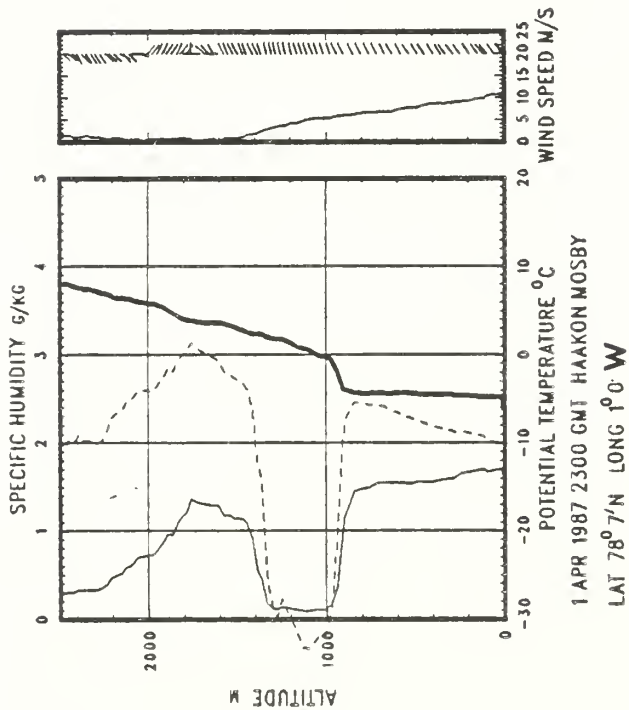


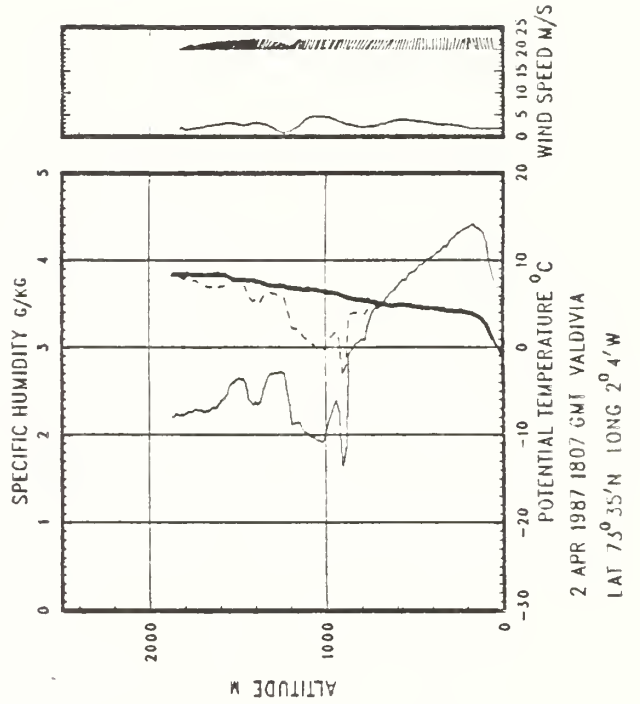
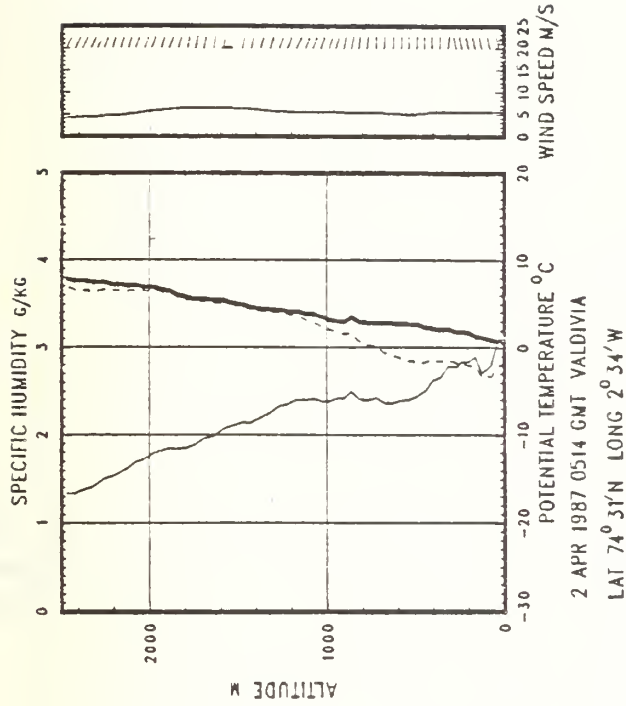
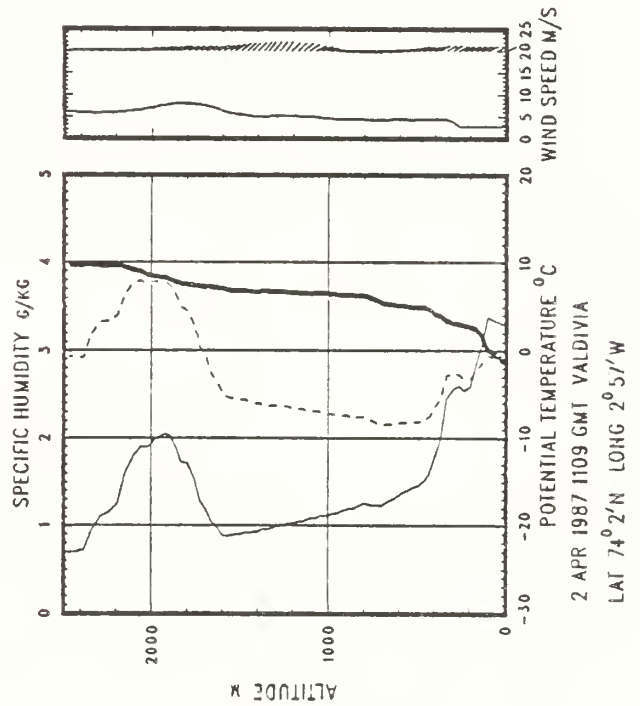
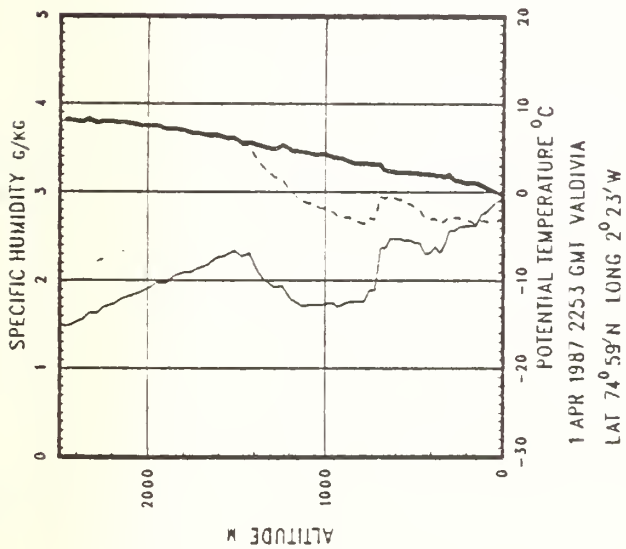
1200 UT 2 April 1987

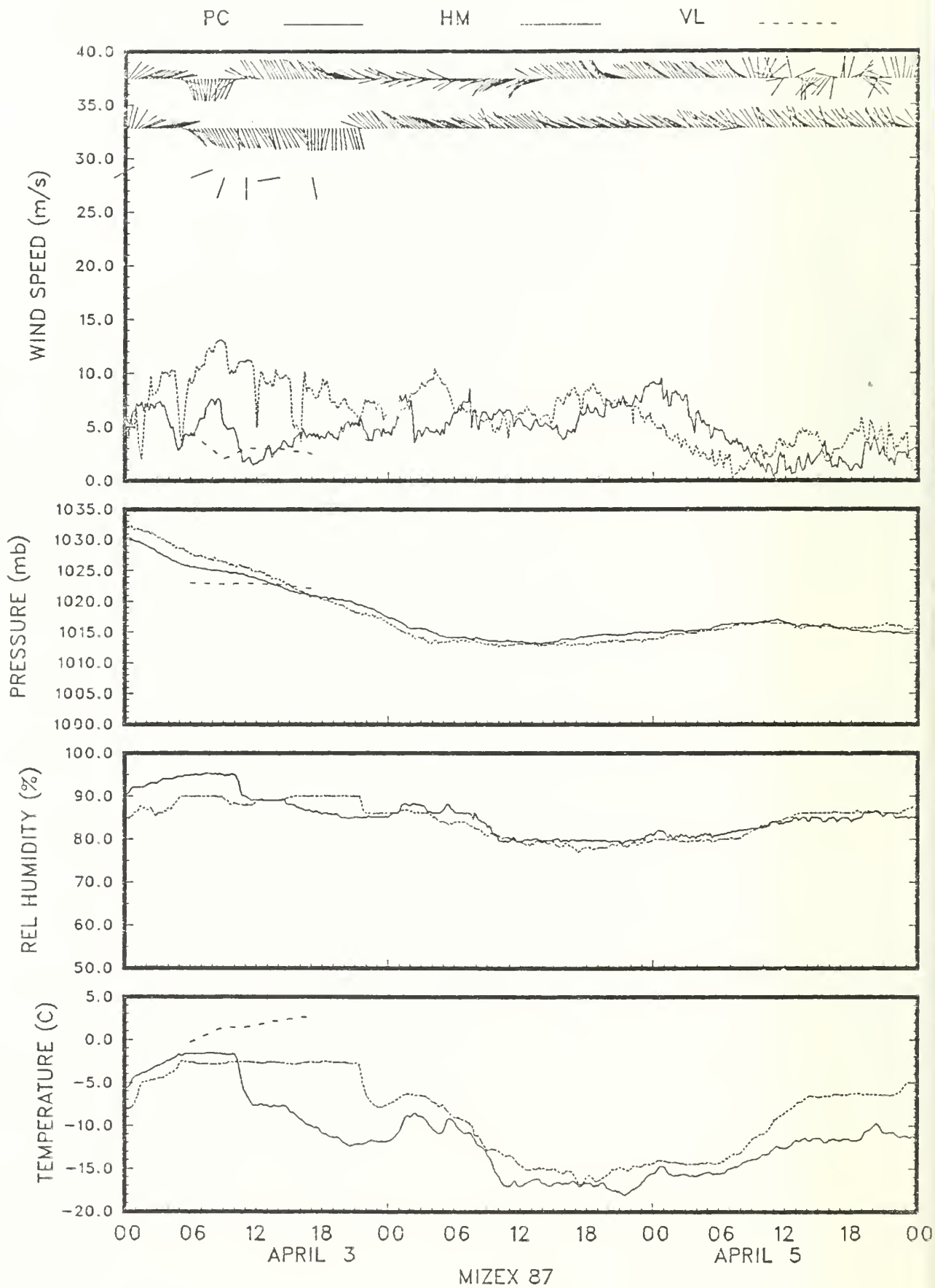


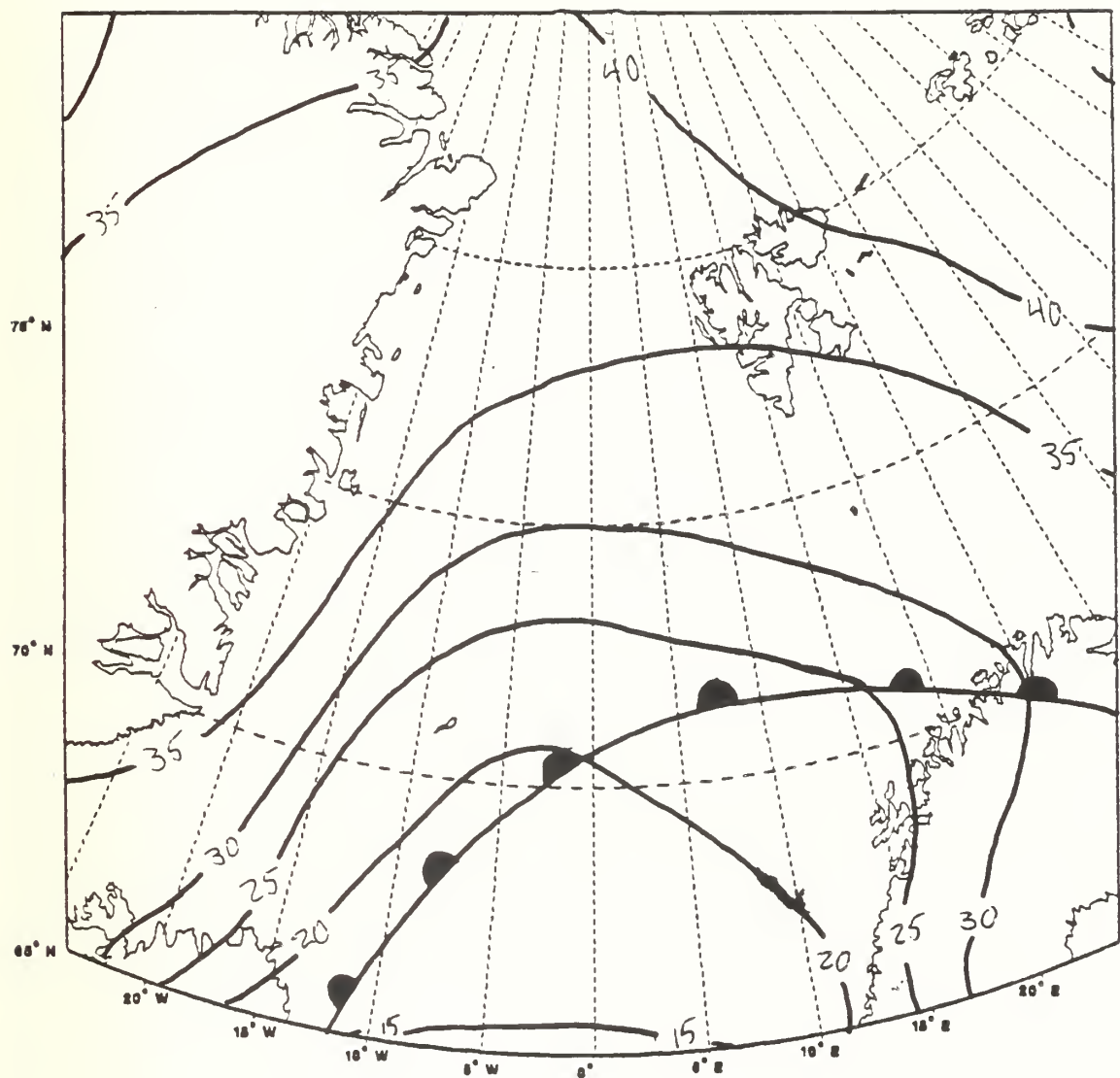
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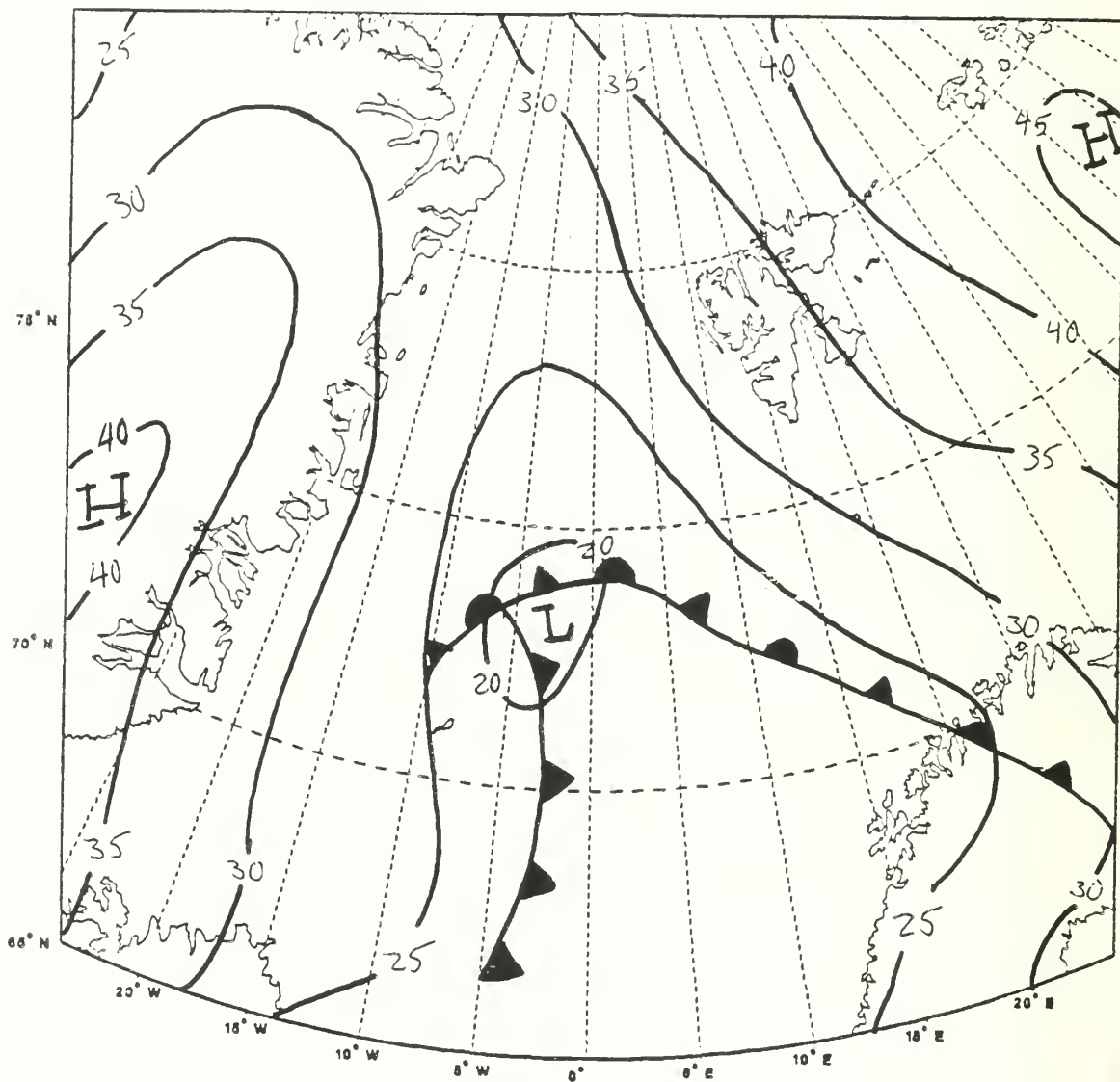




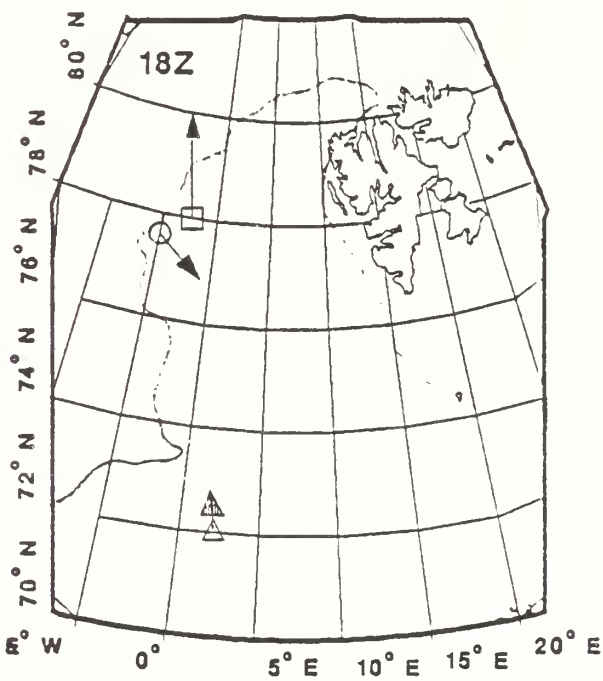
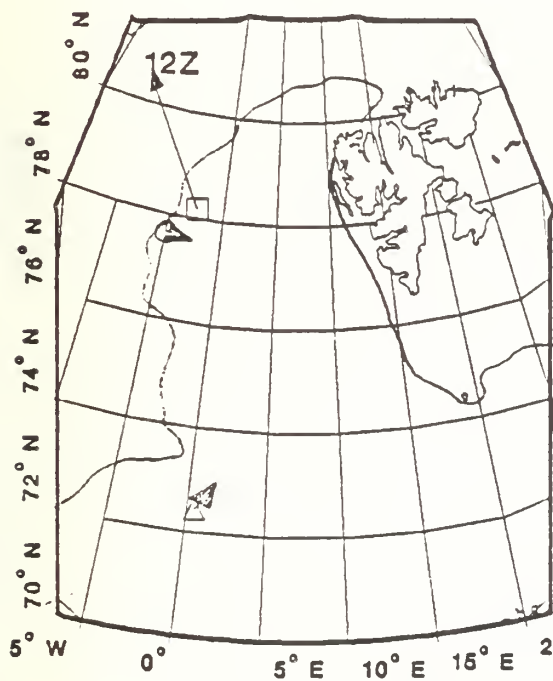
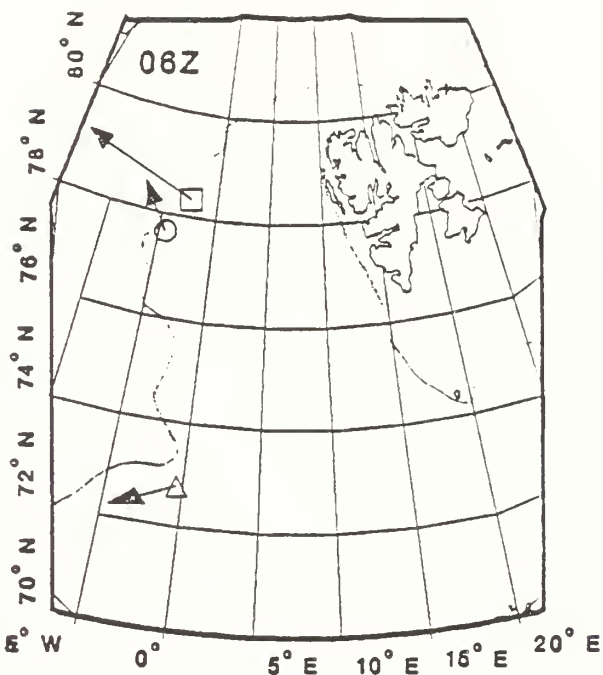
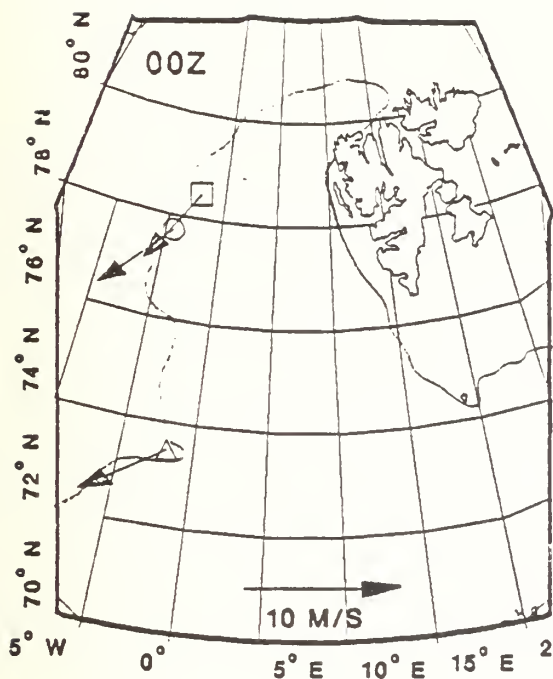




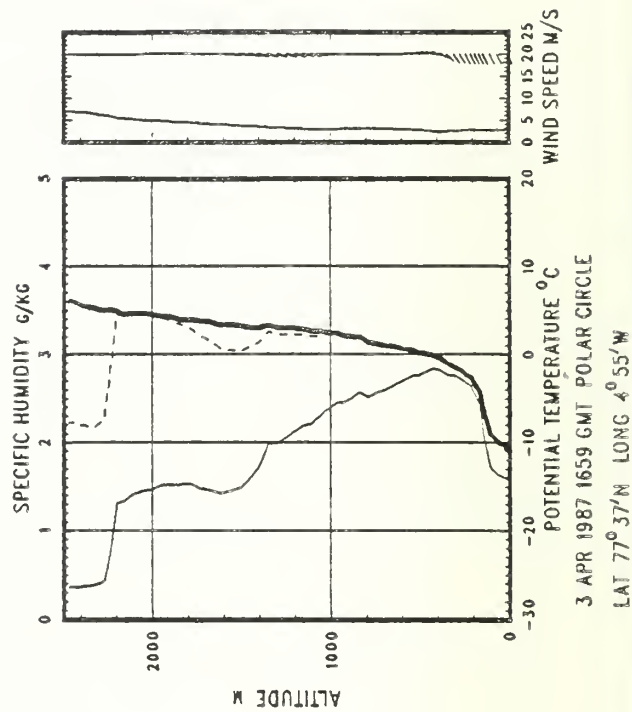
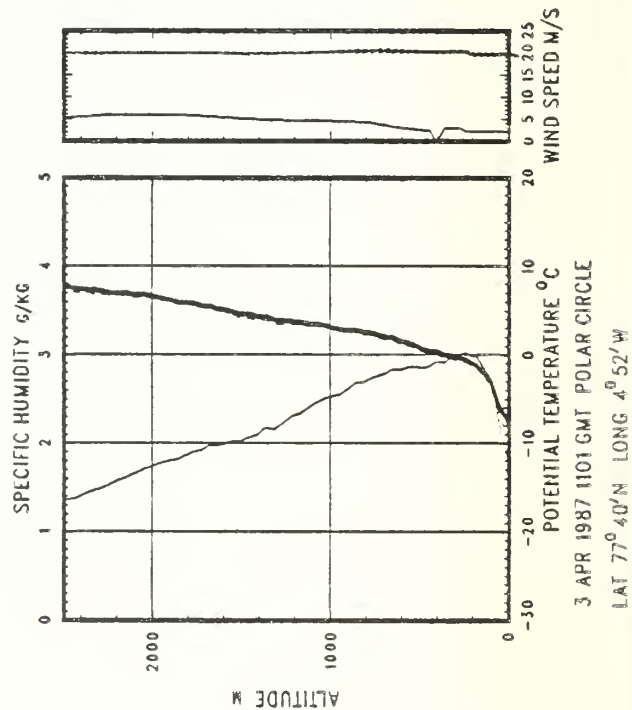
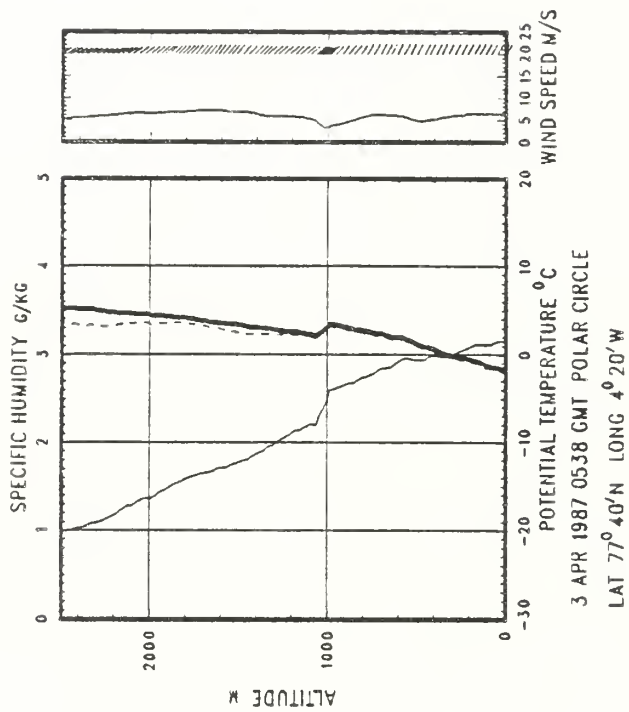
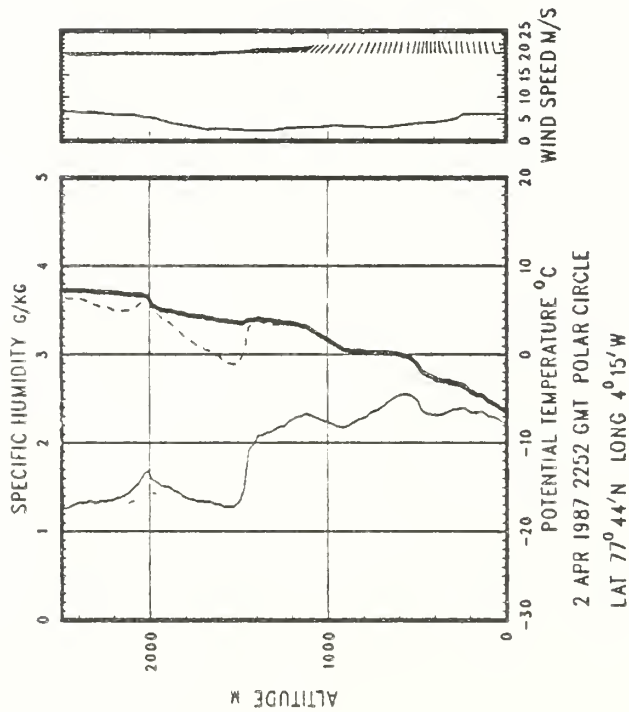
0000 UT 3 April 1987

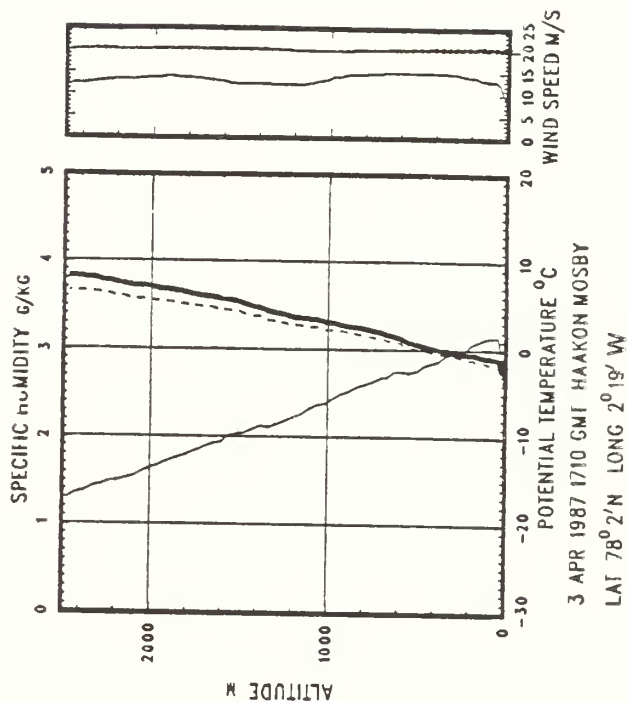
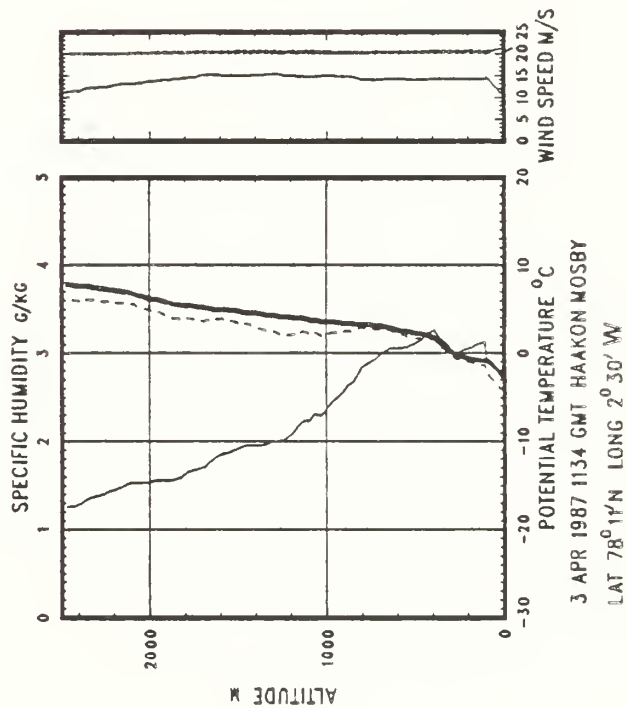
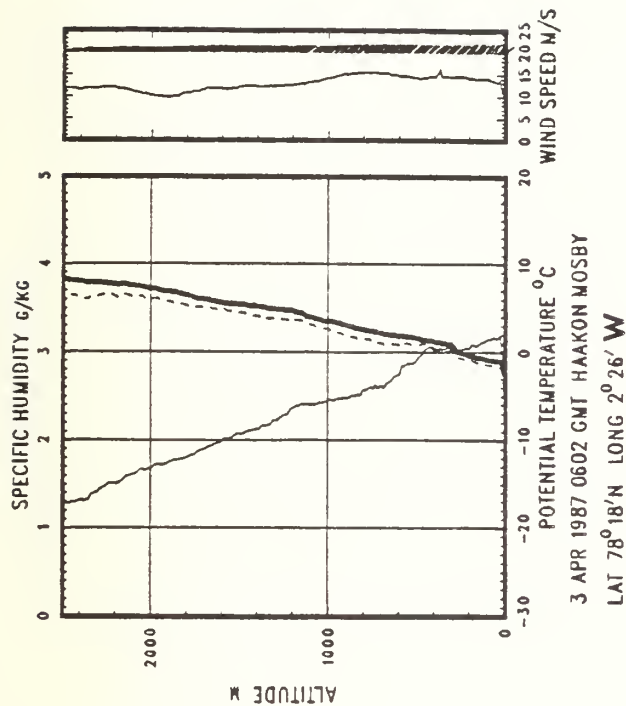
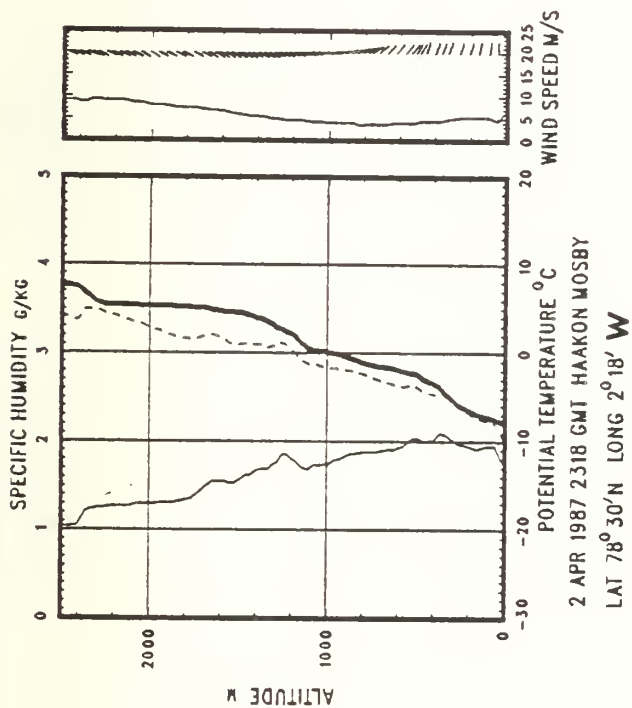


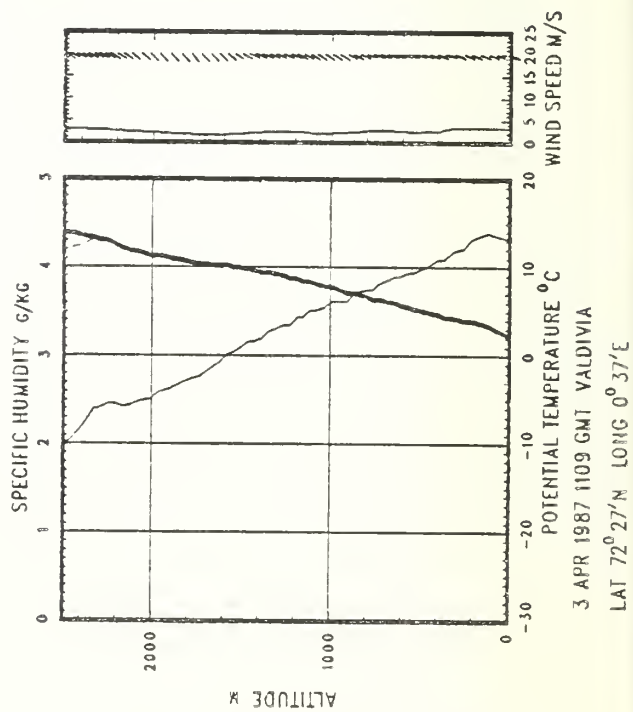
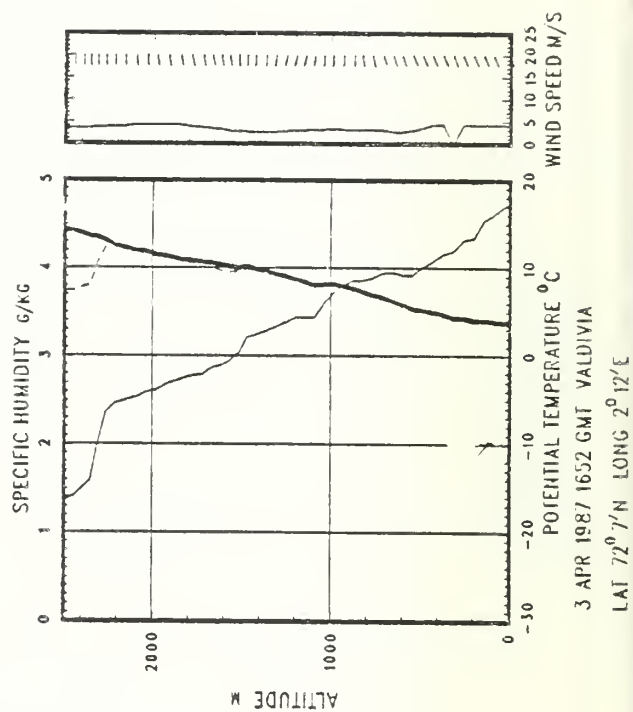
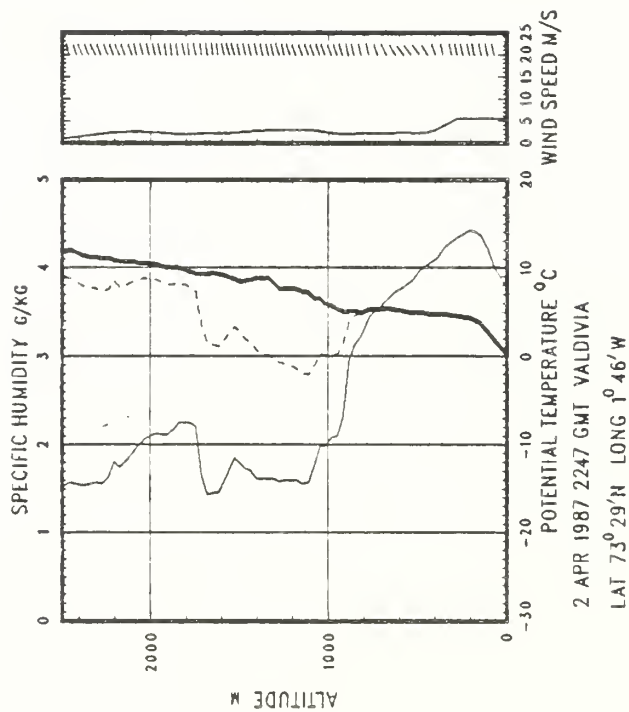
1200 UT 3 April 1987

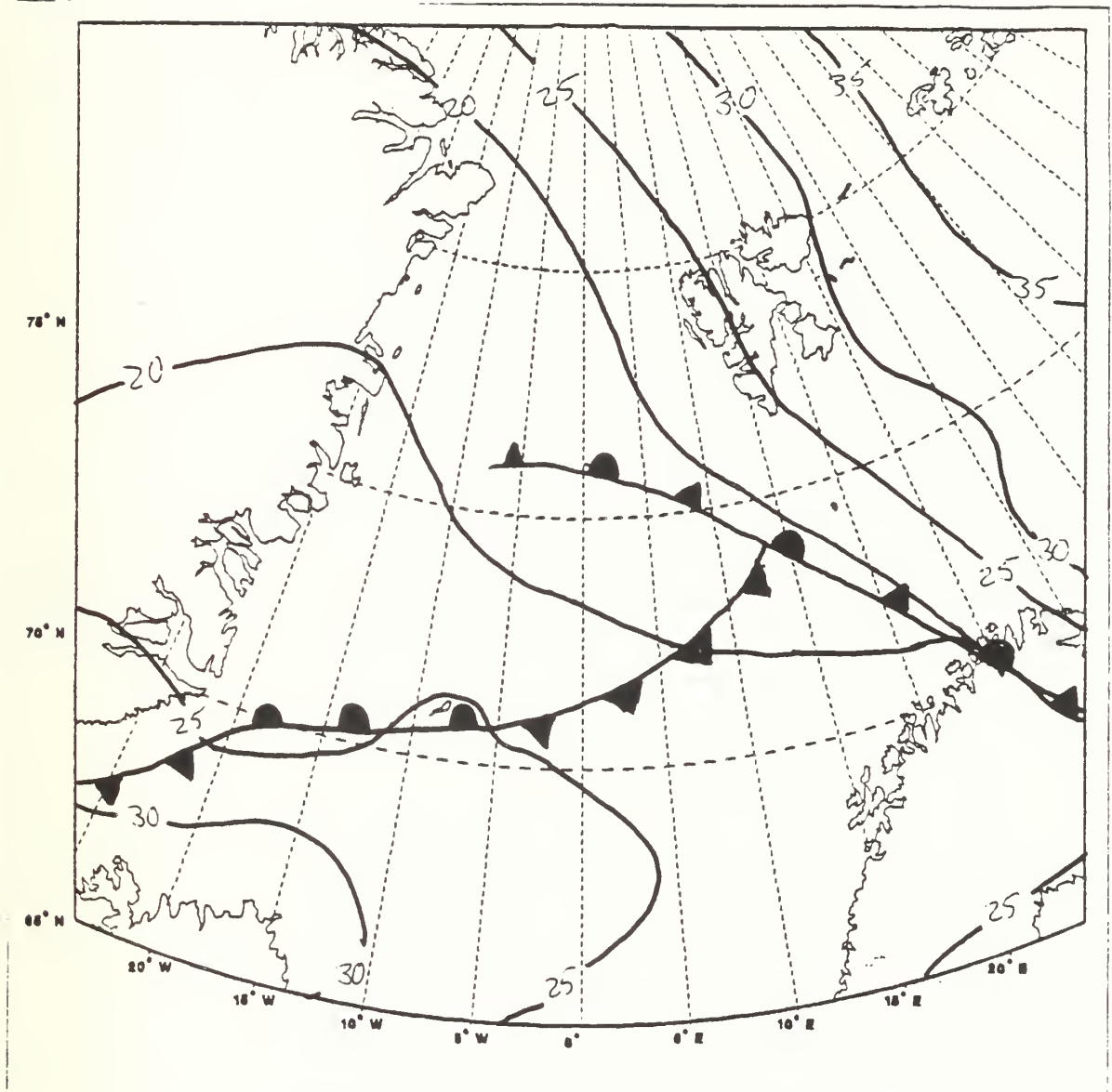


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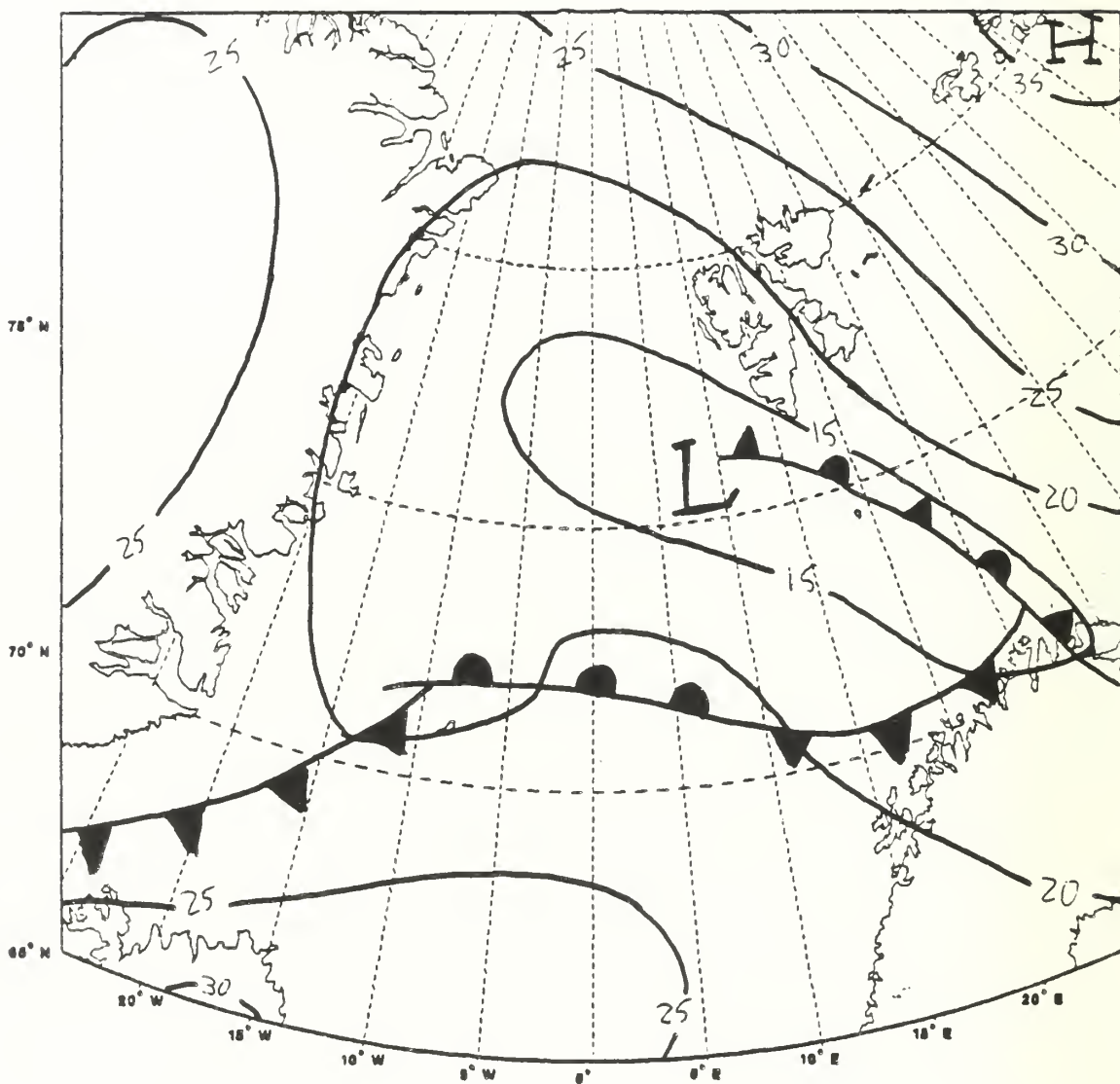




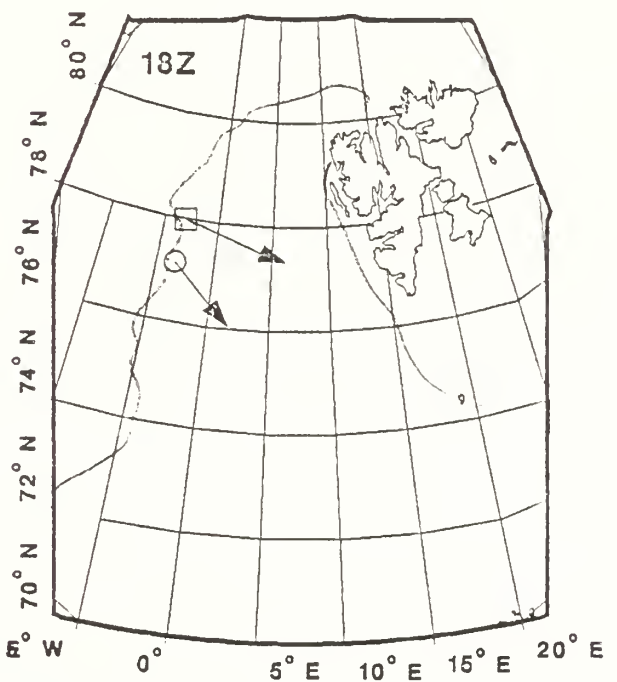
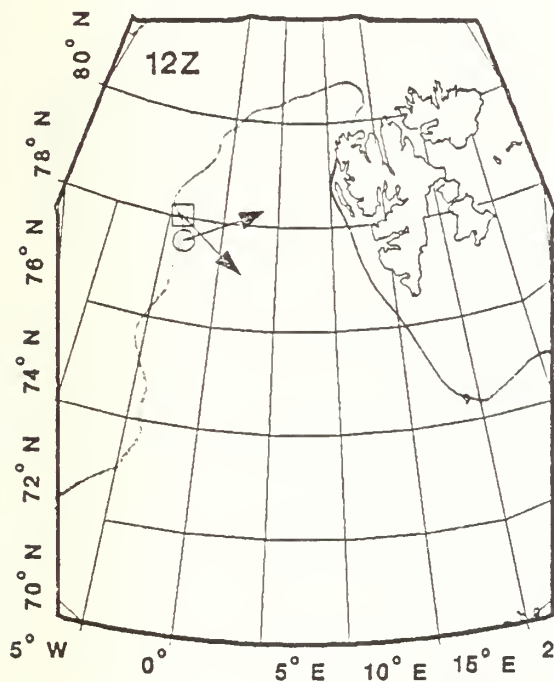
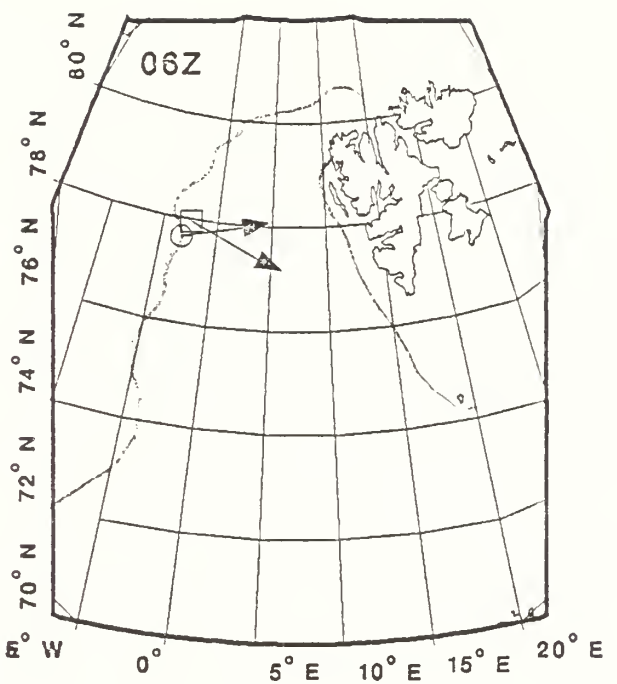
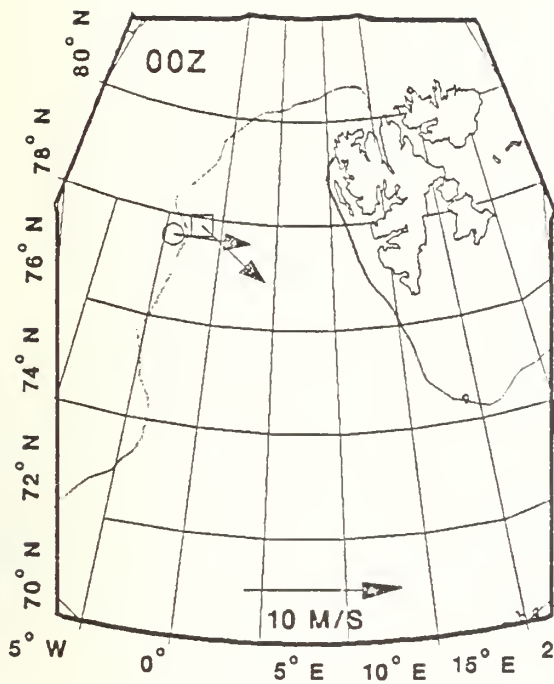




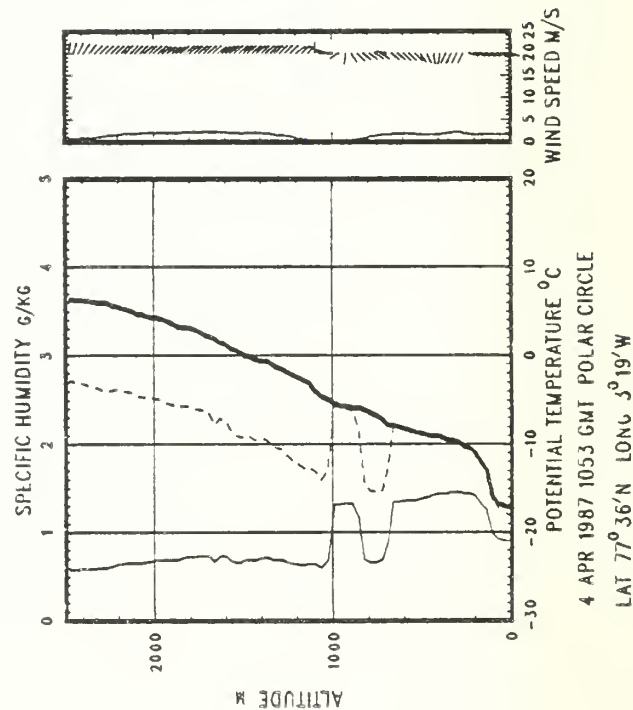
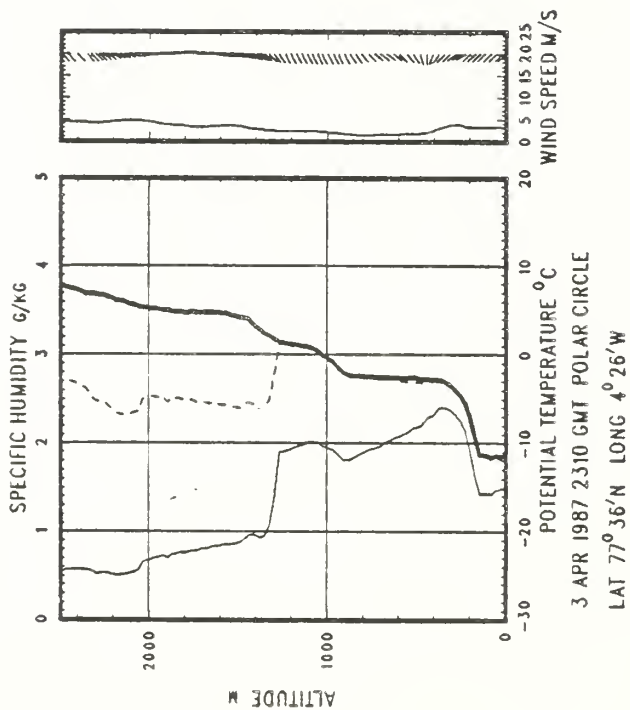
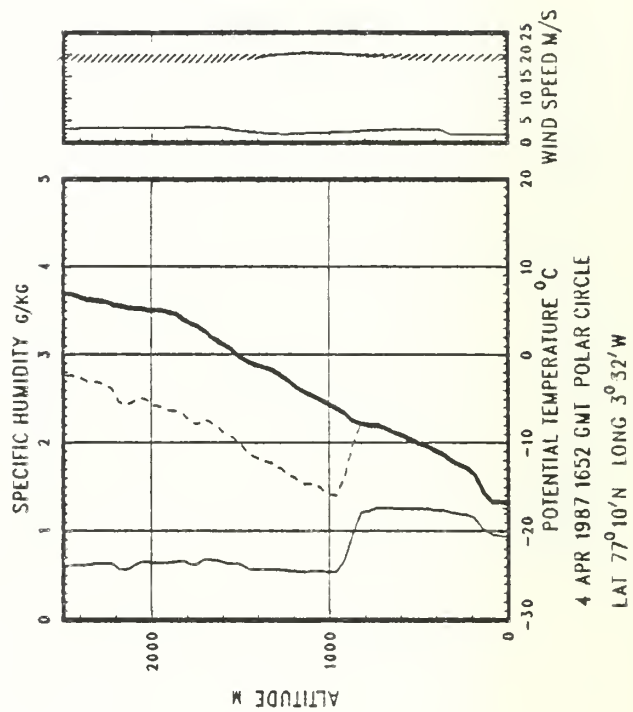
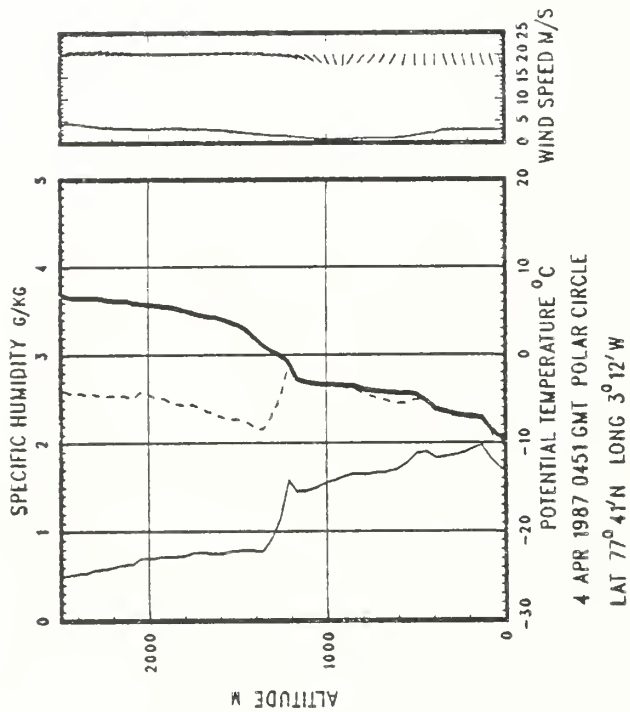
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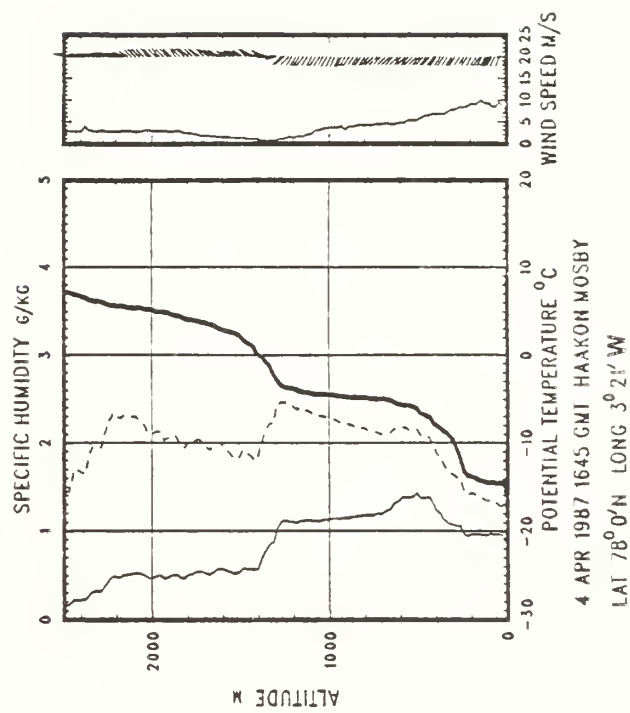
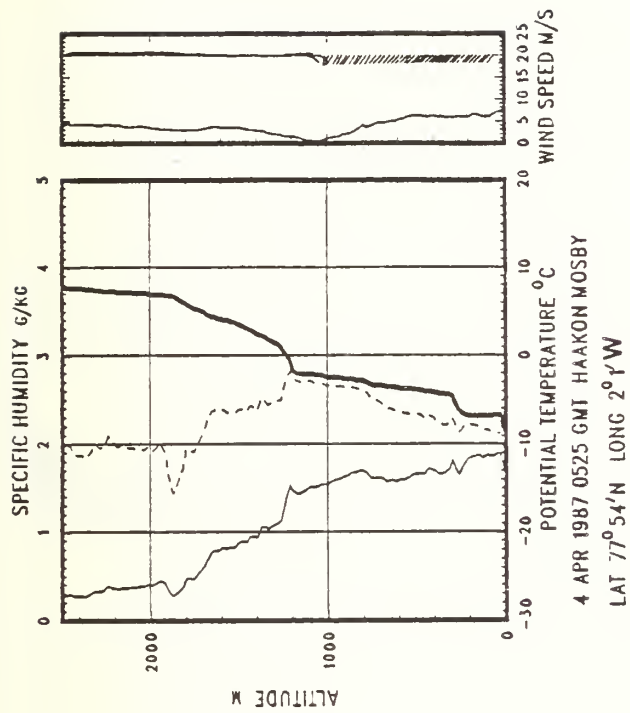
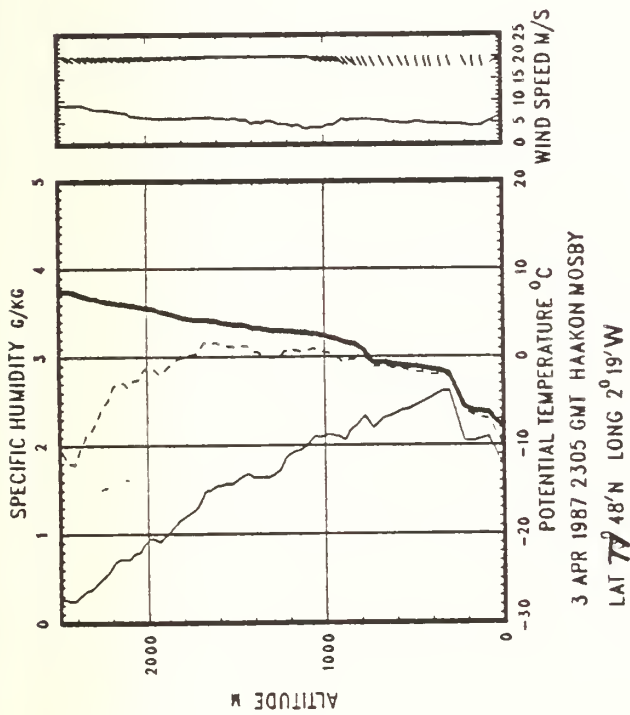


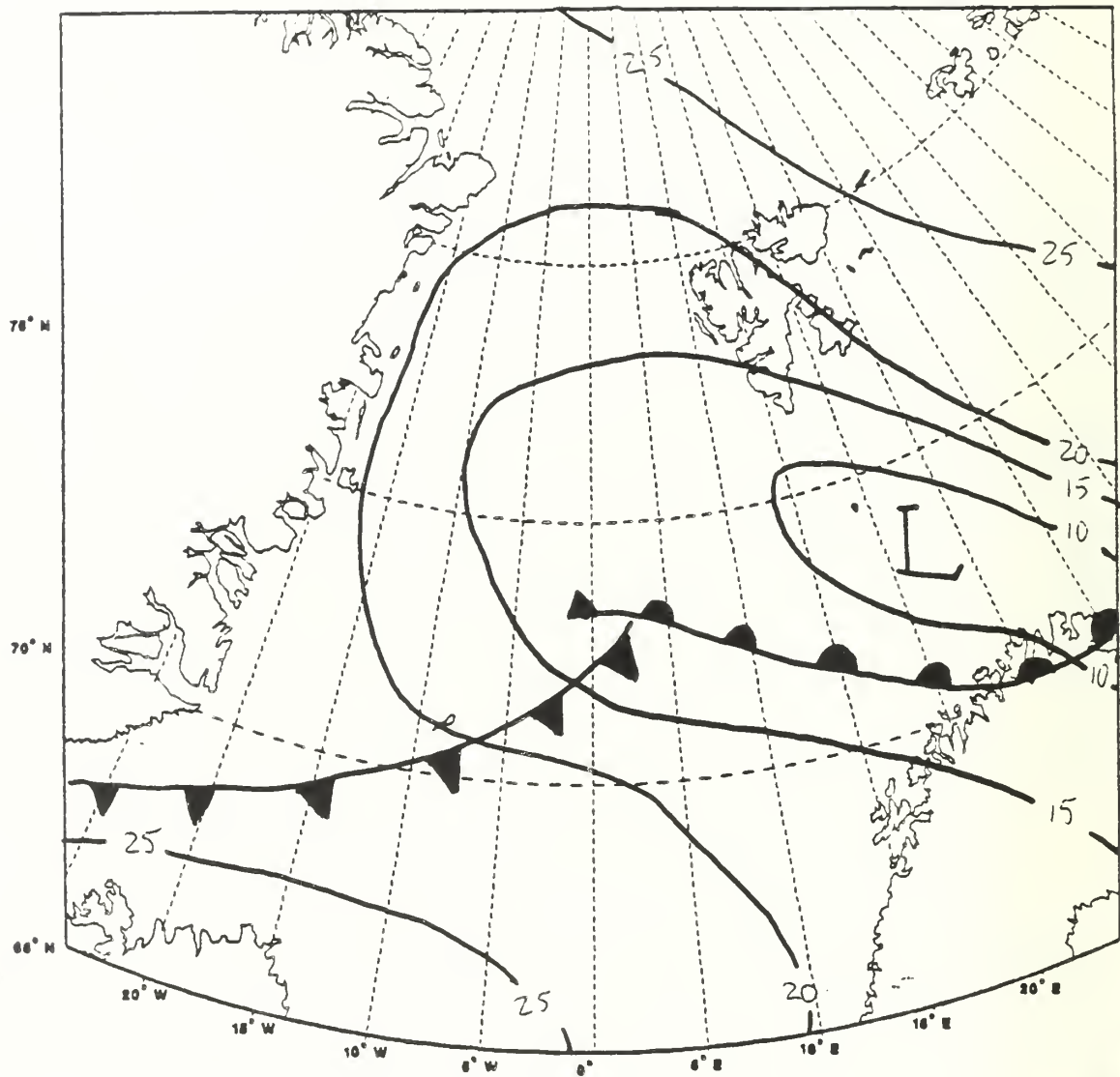
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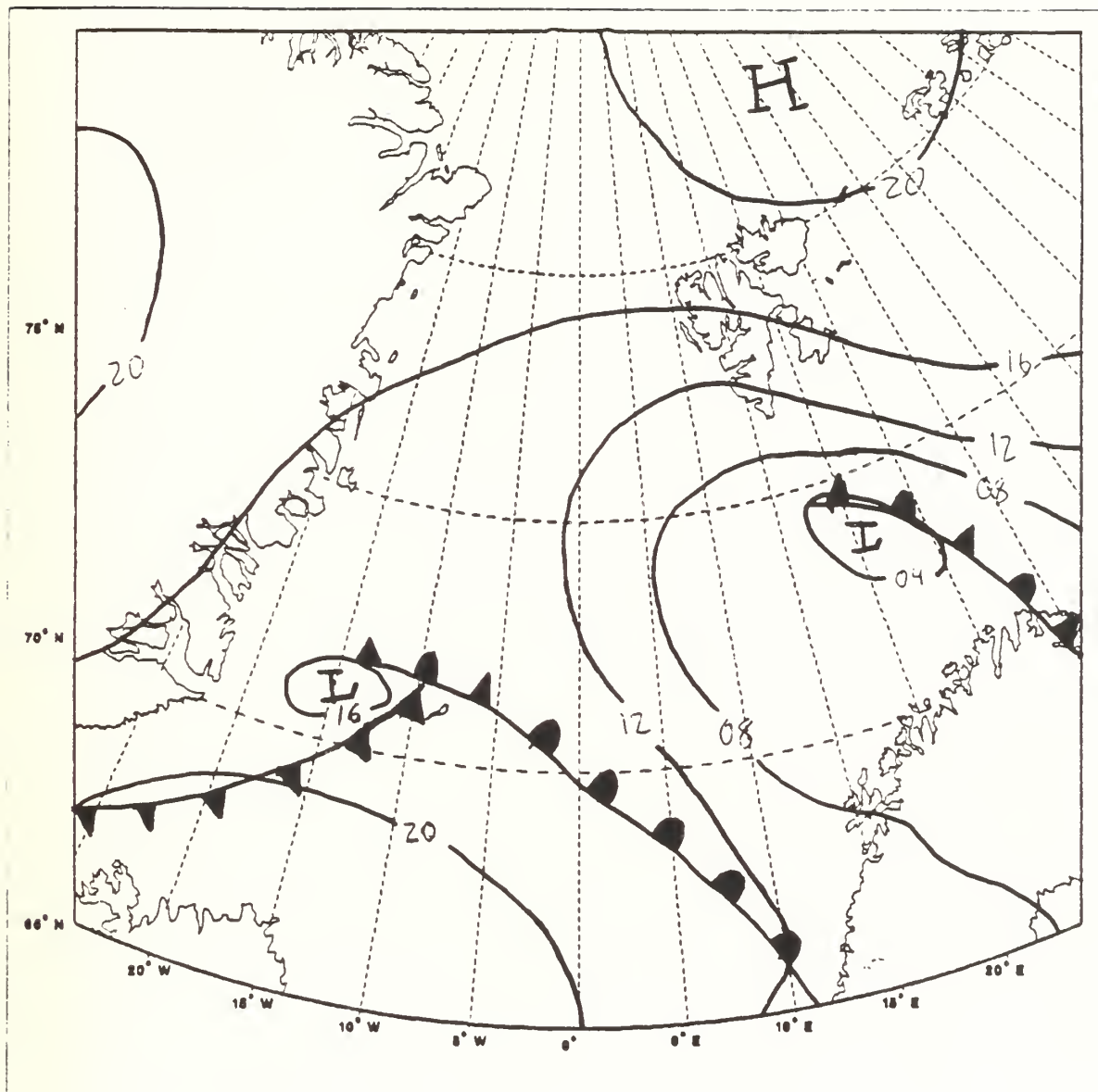
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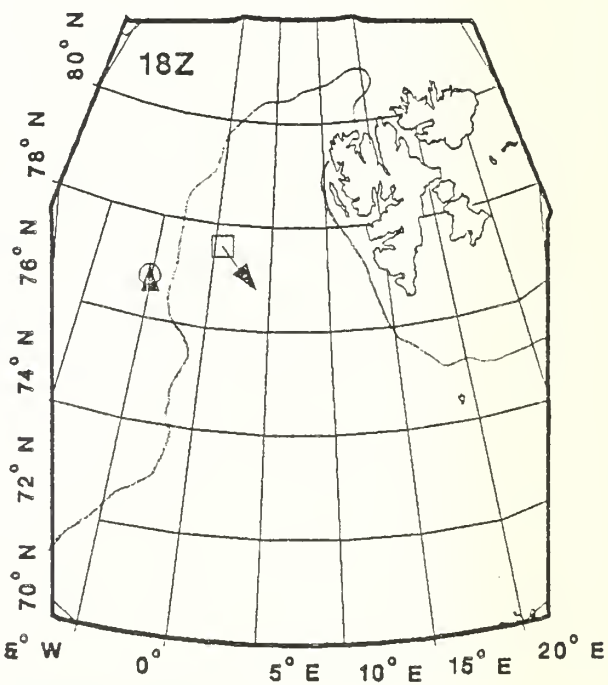
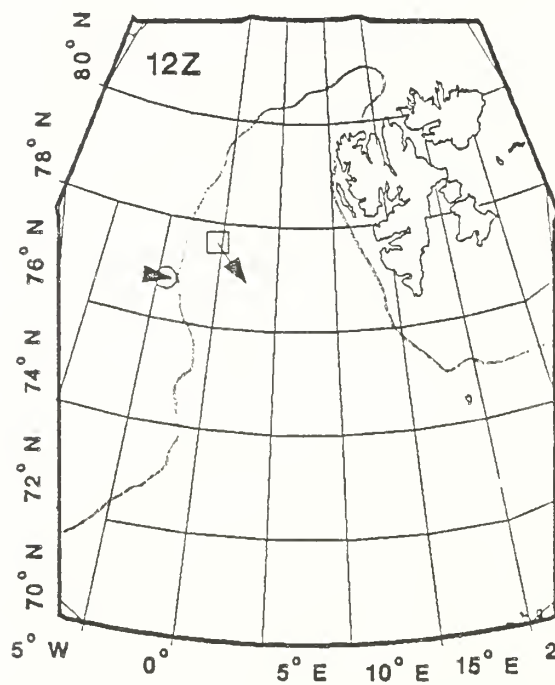
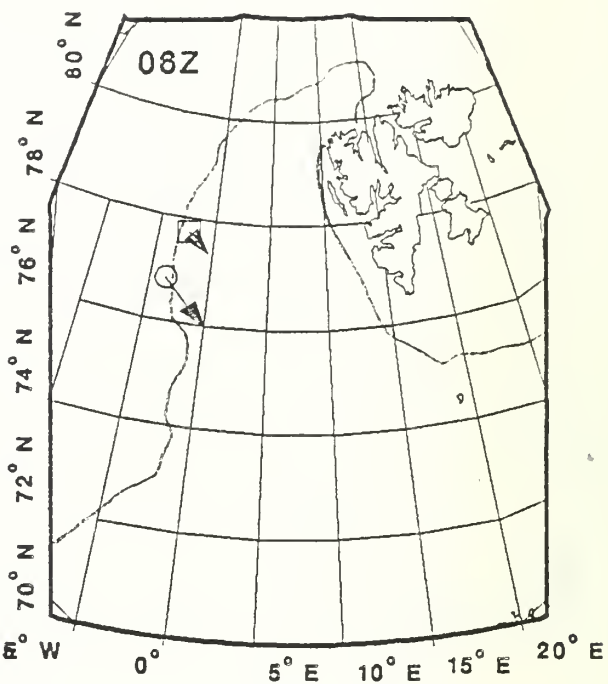
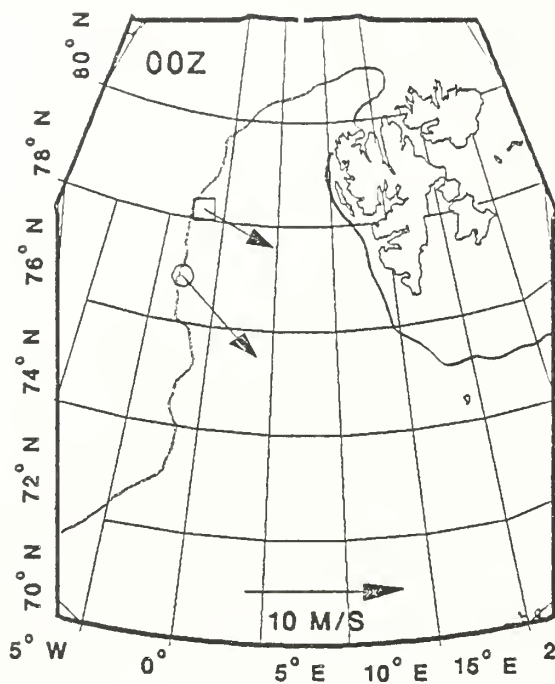




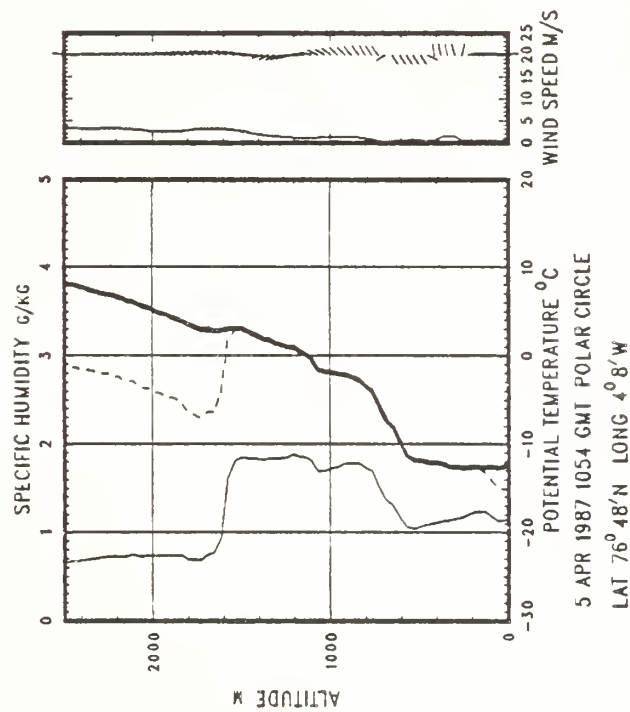
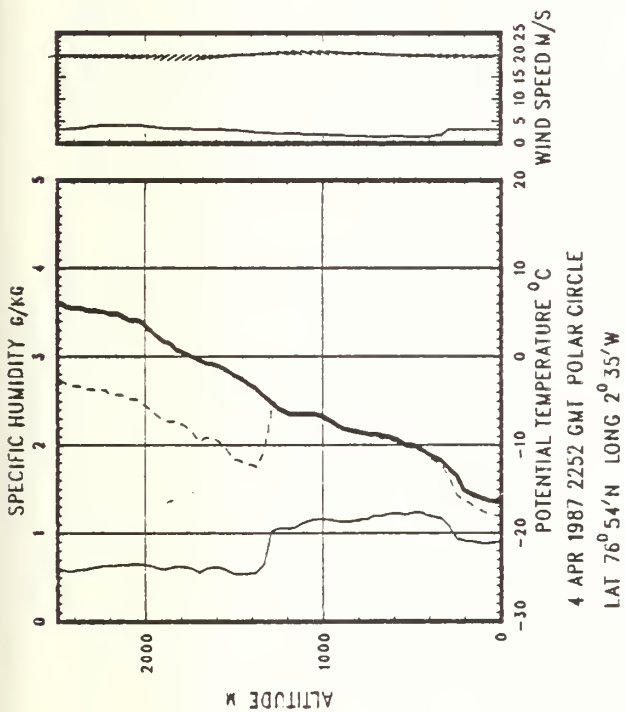
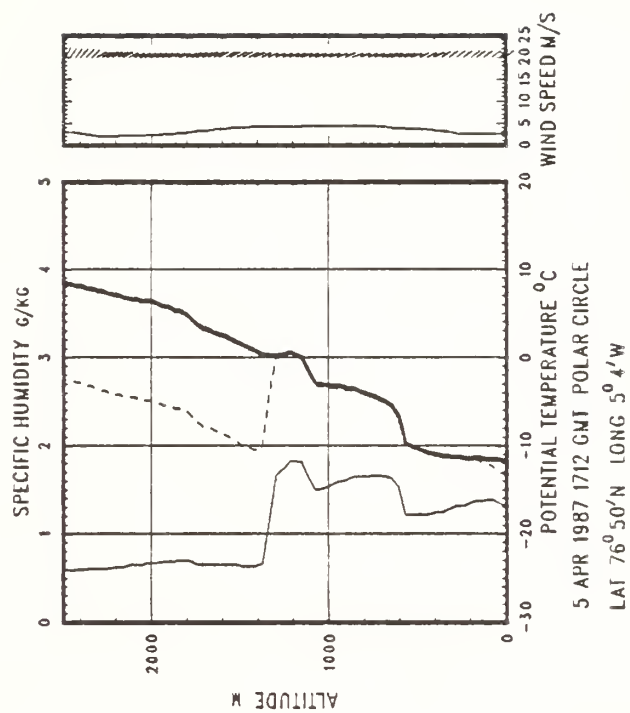
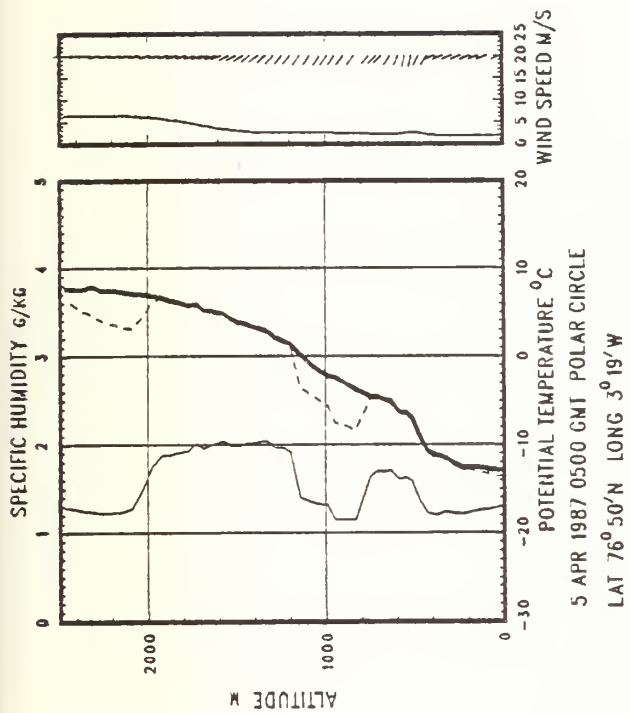
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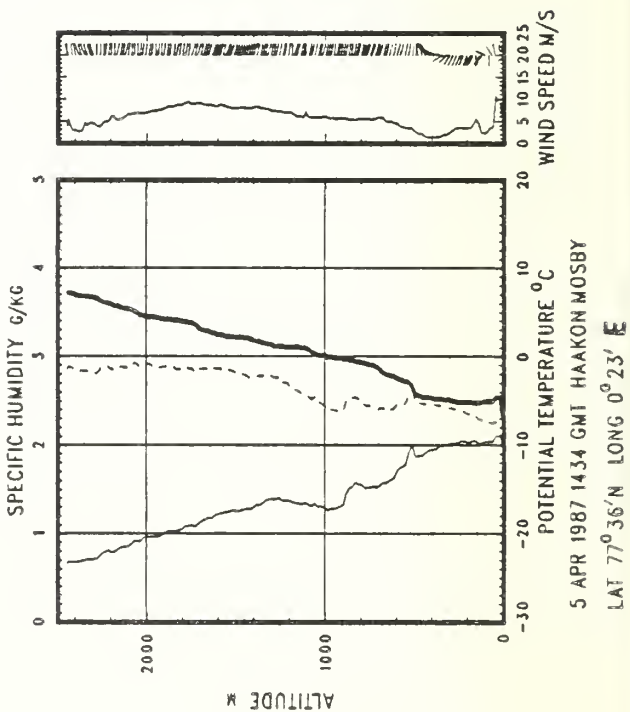
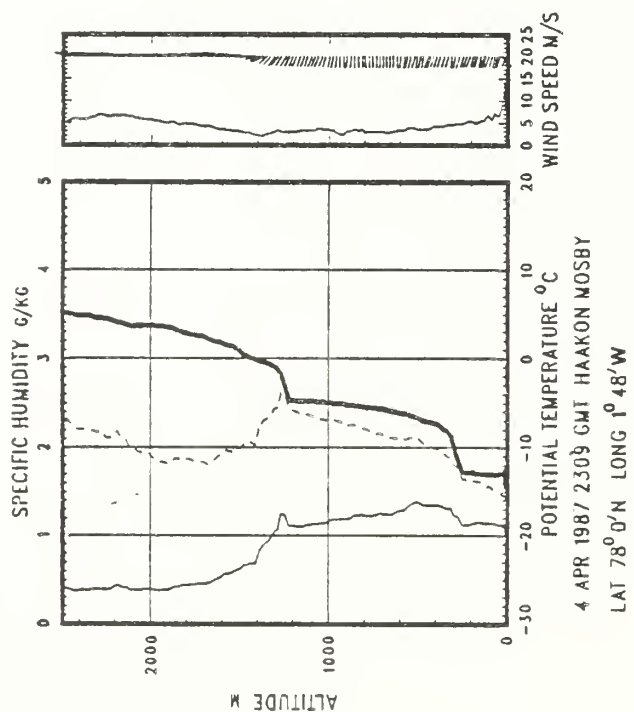
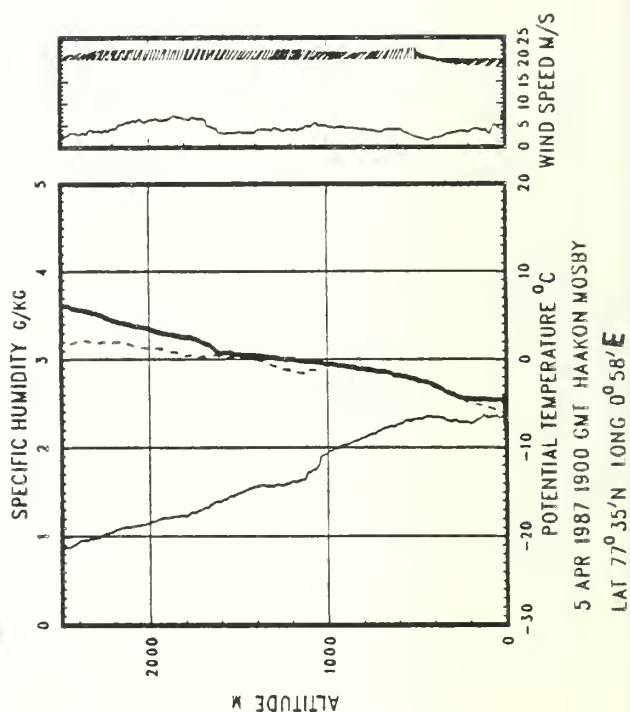
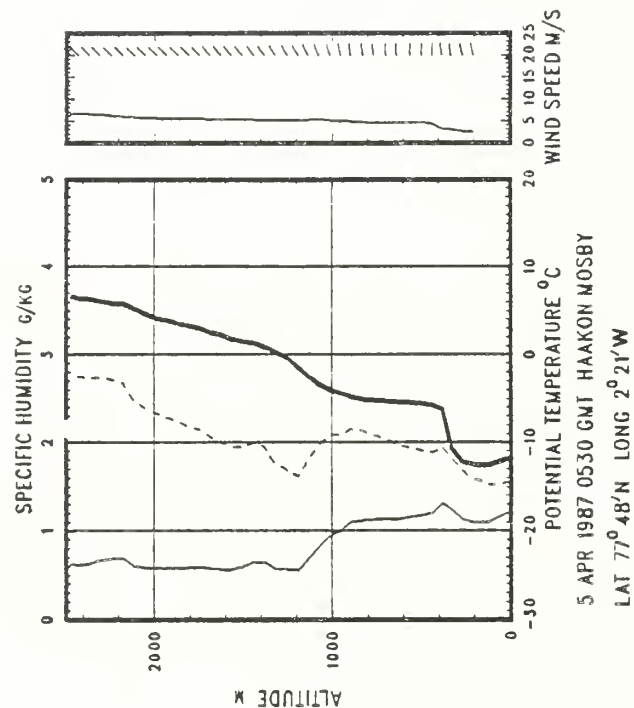


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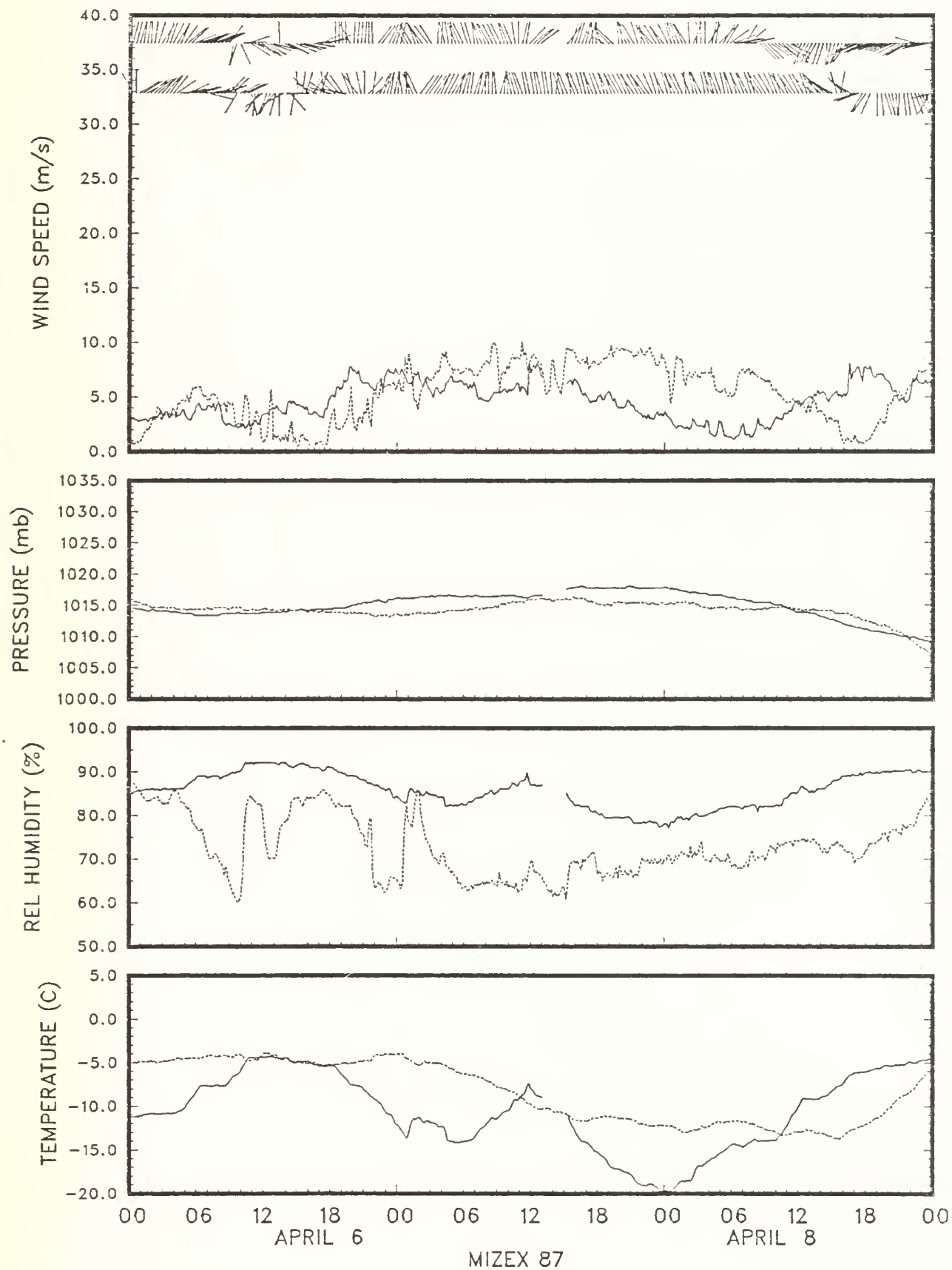
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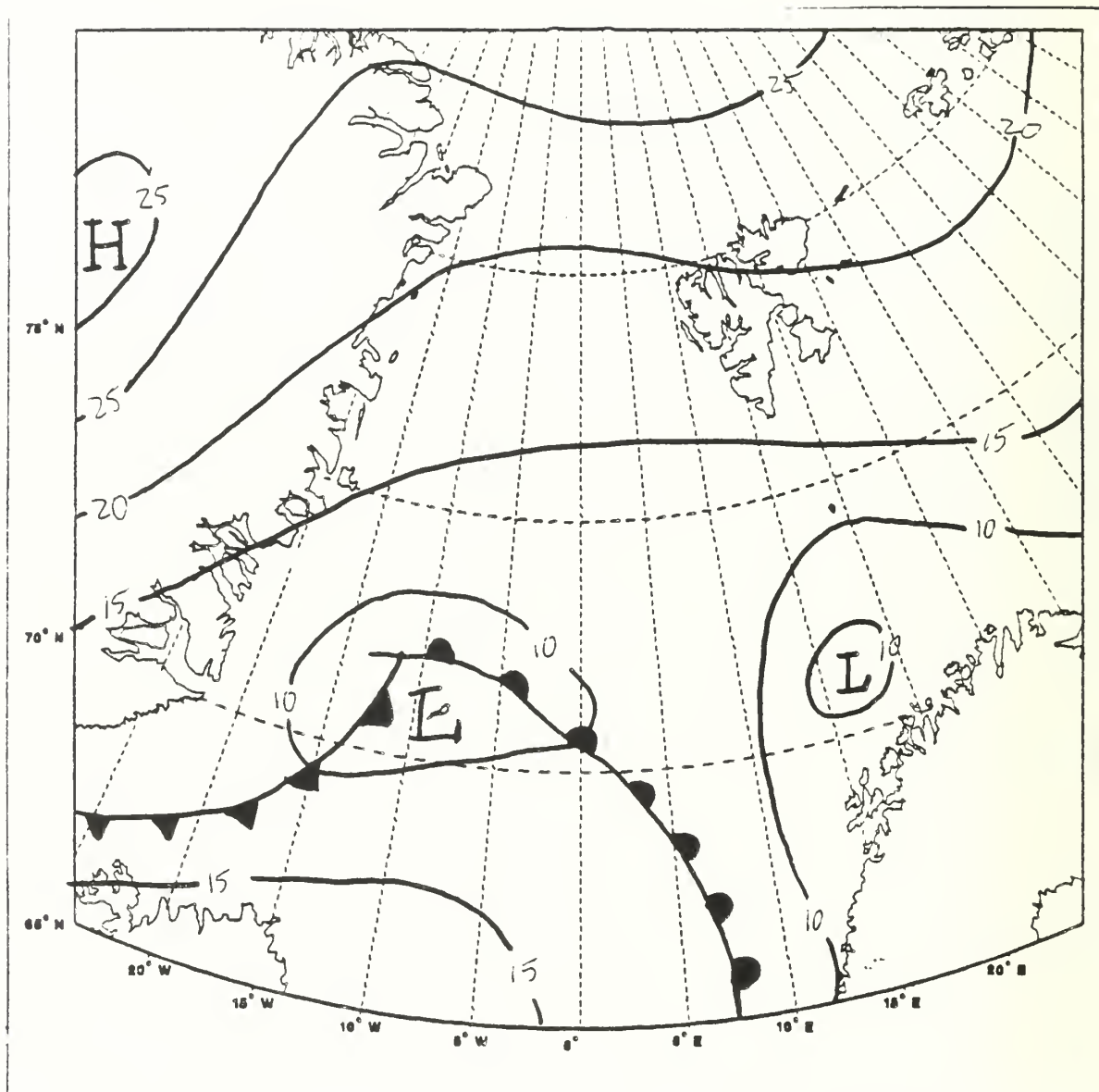
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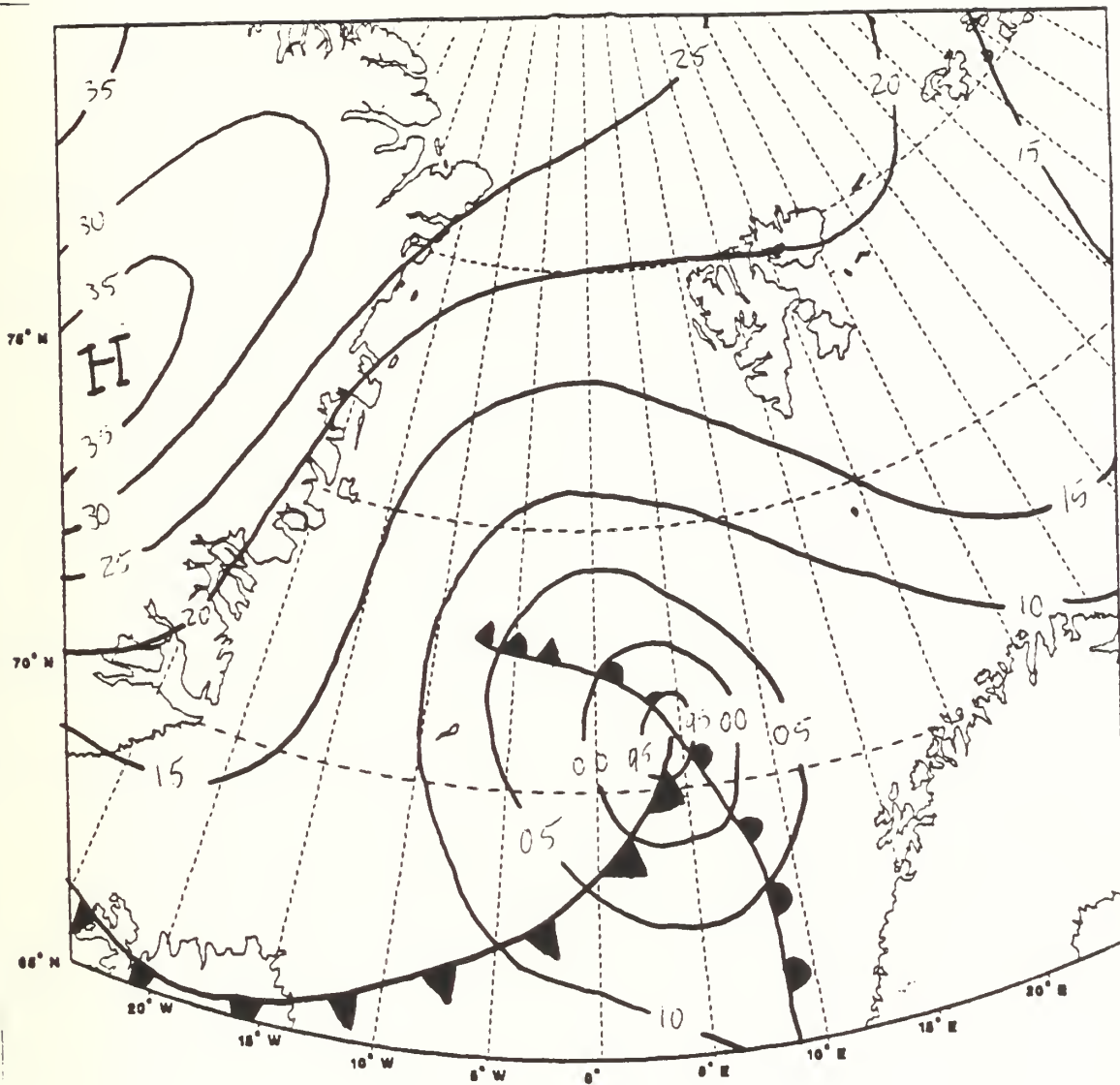
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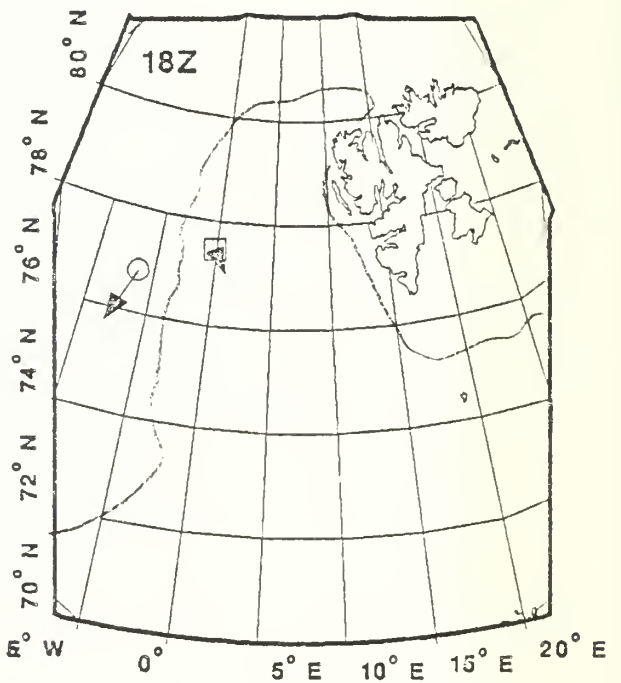
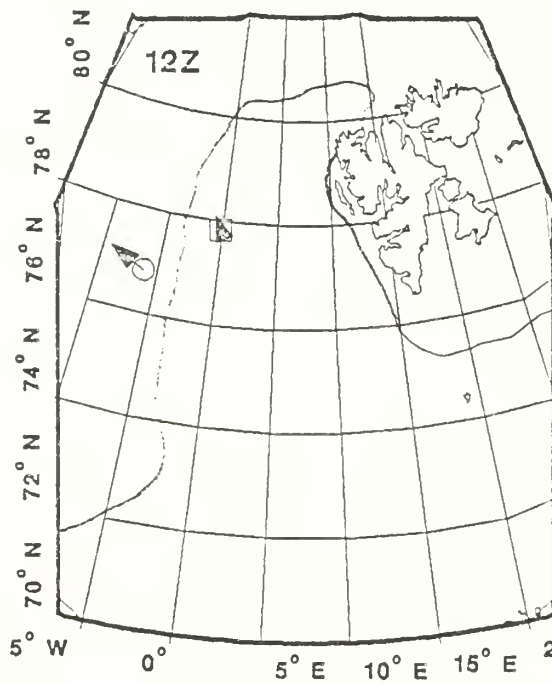
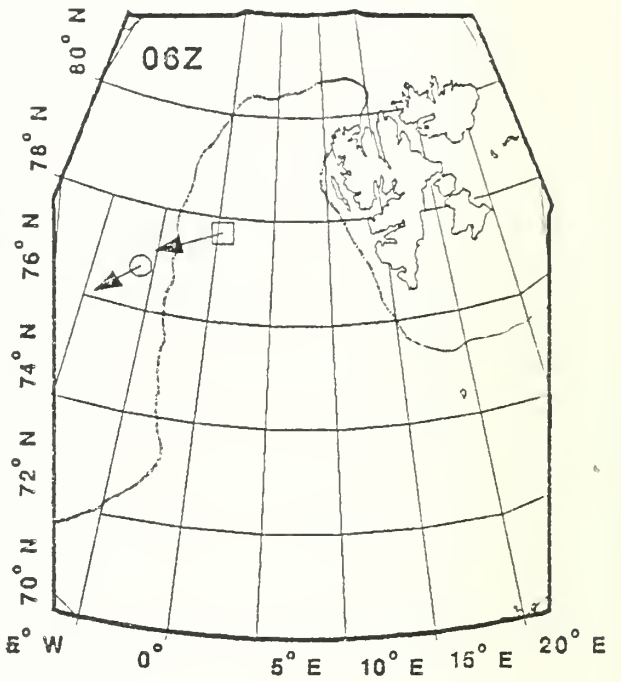
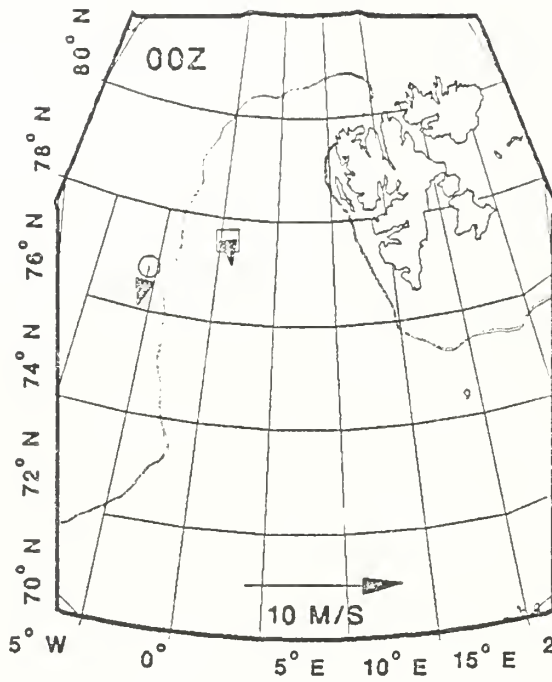




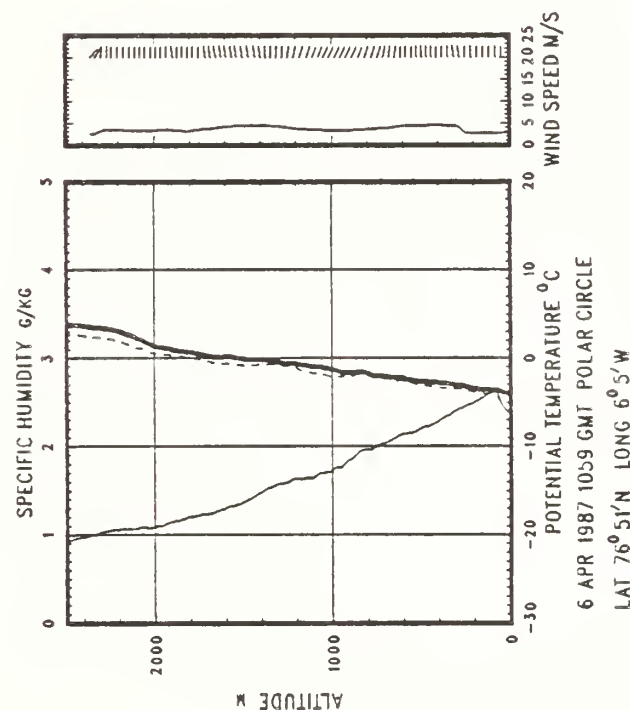
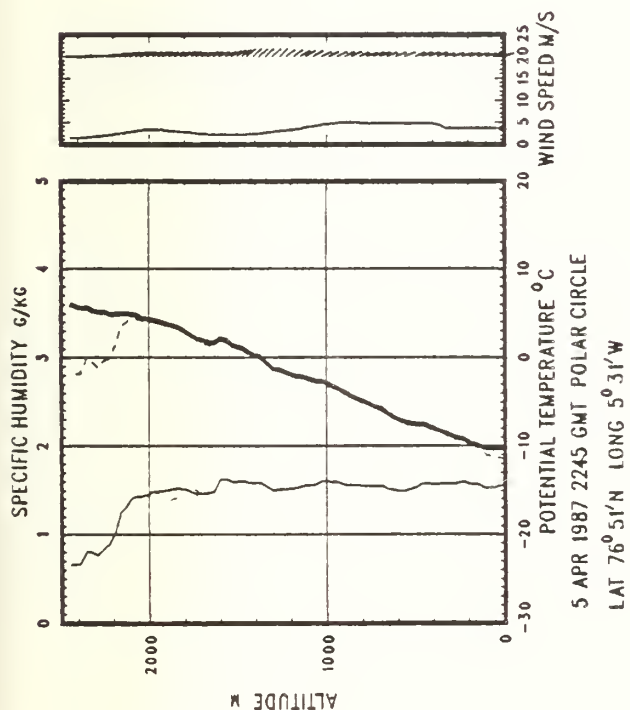
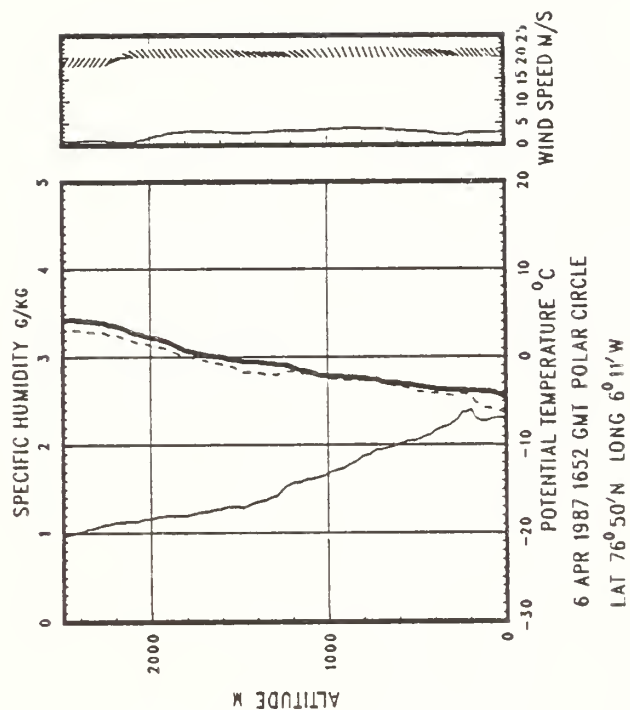
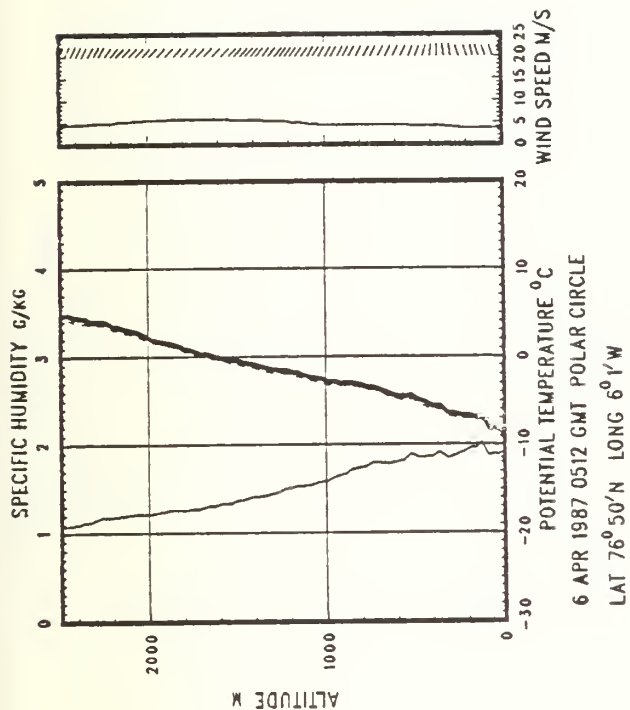
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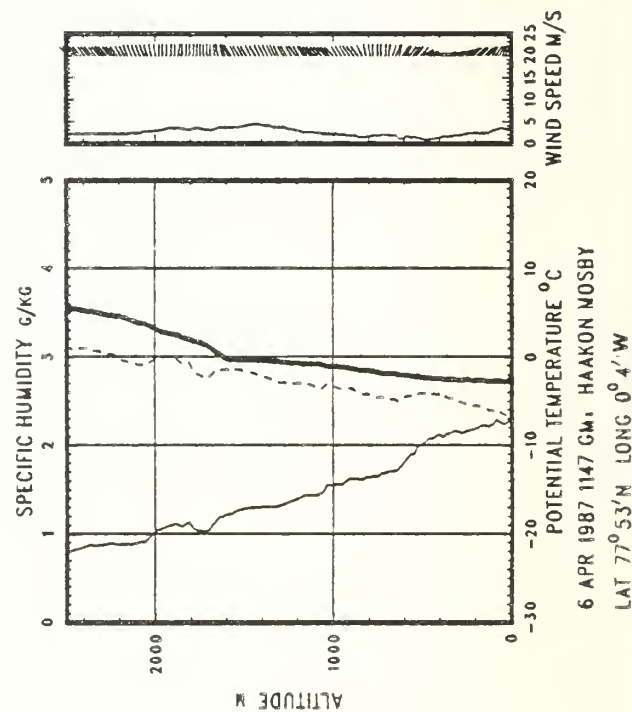
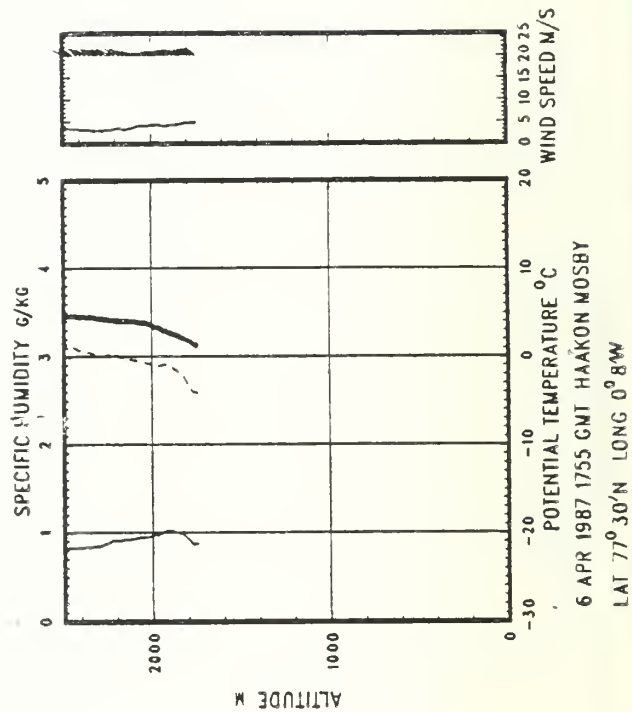
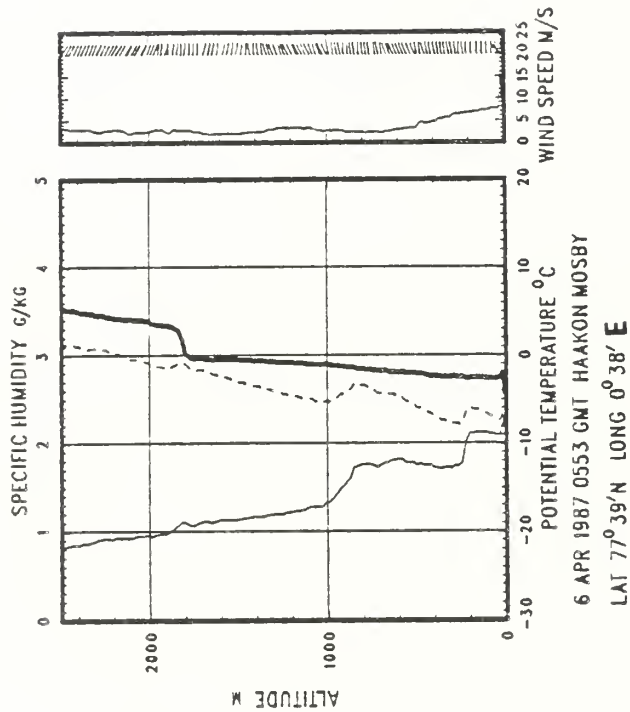


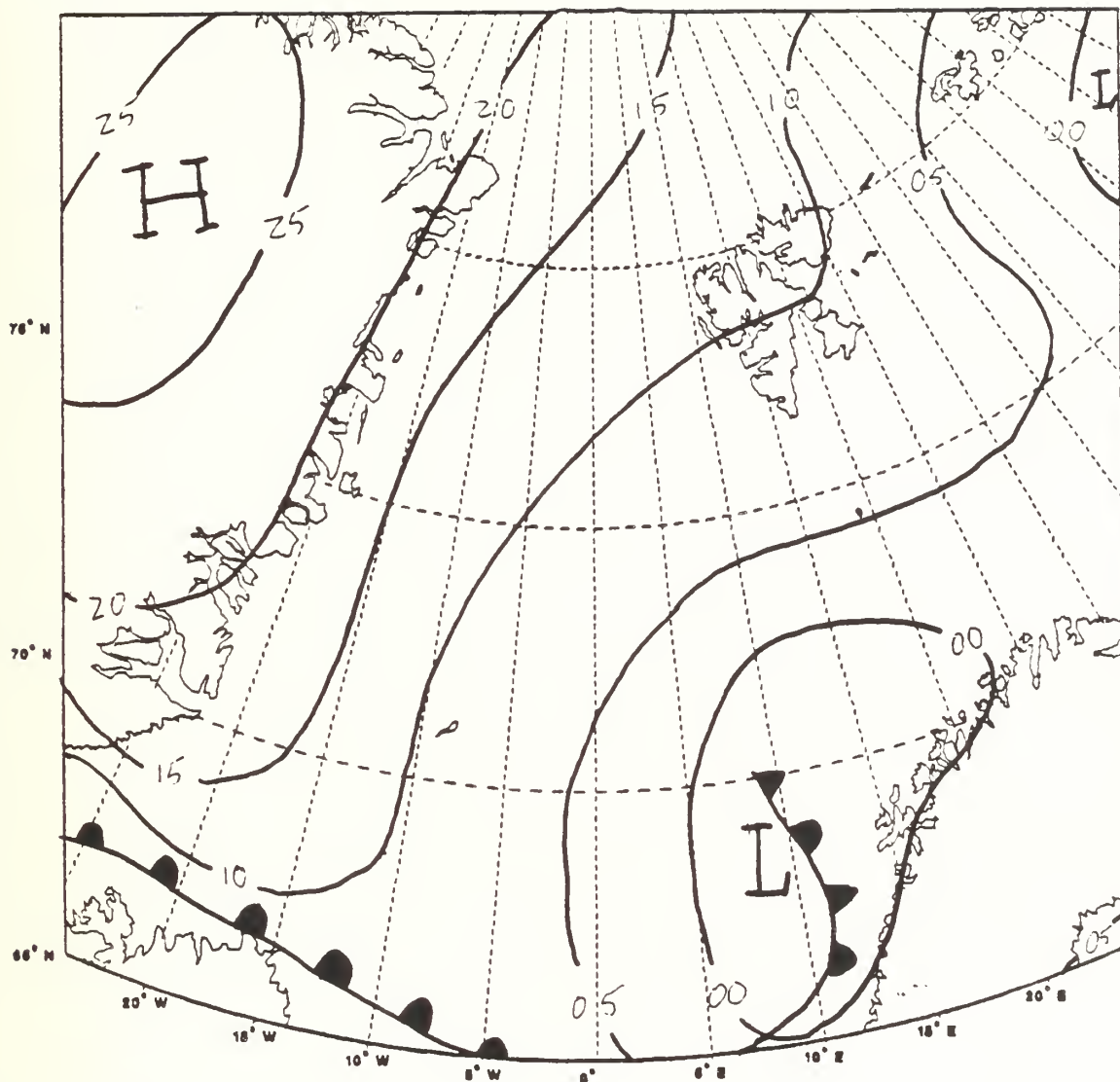
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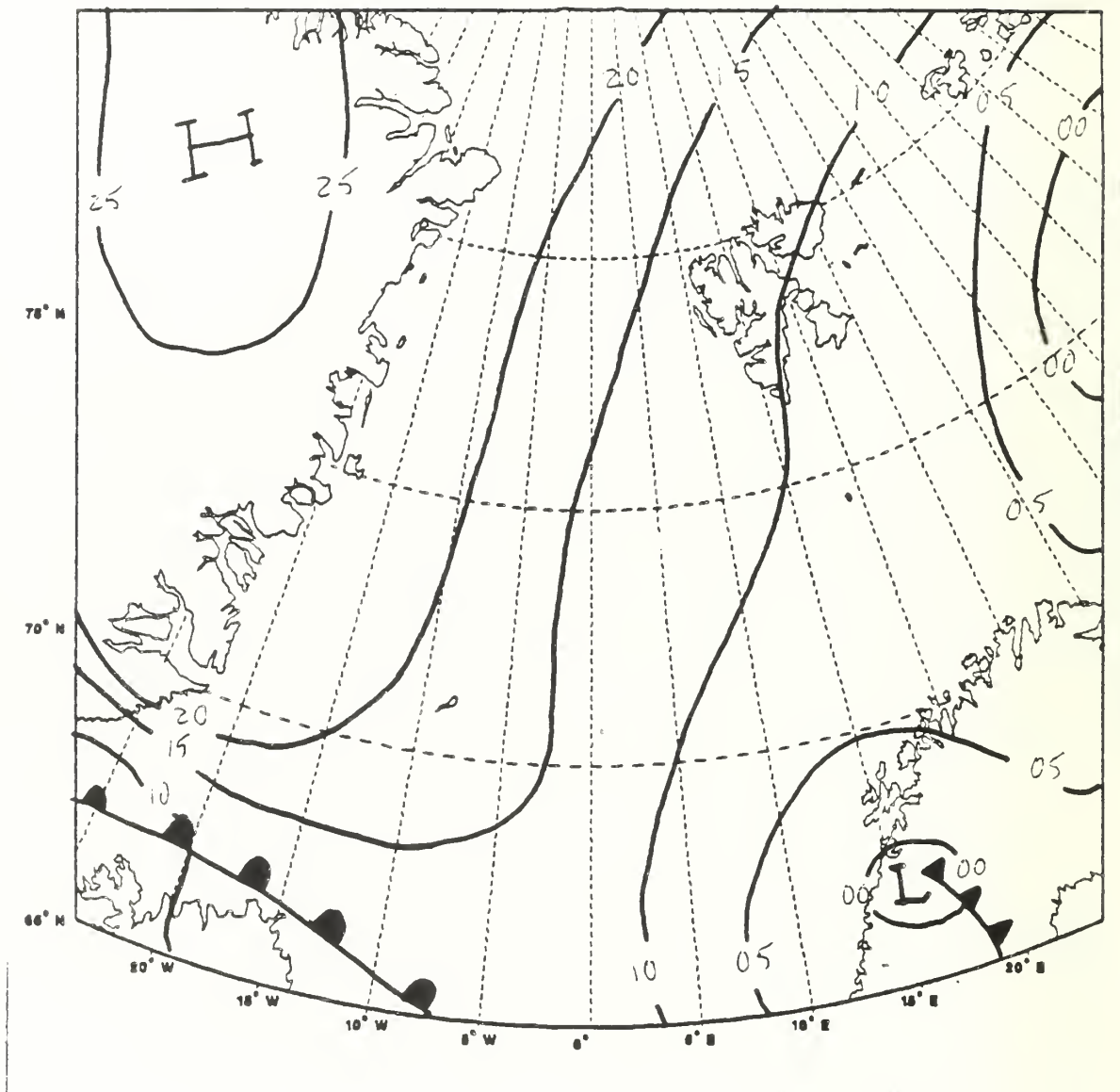
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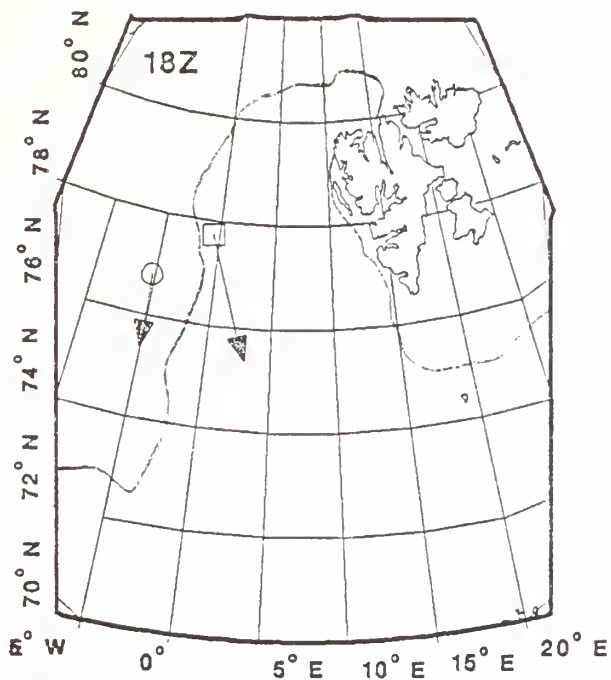
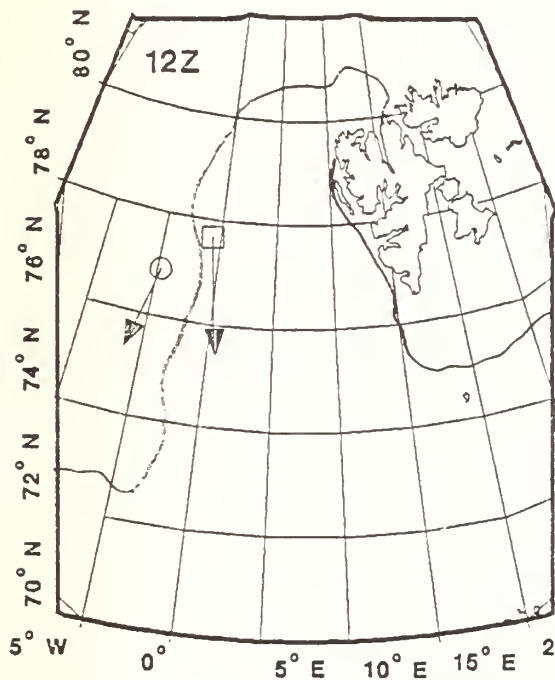
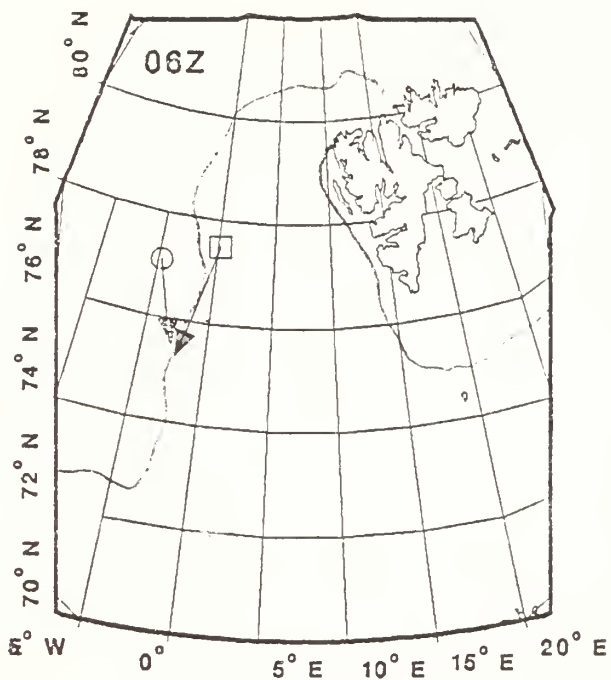
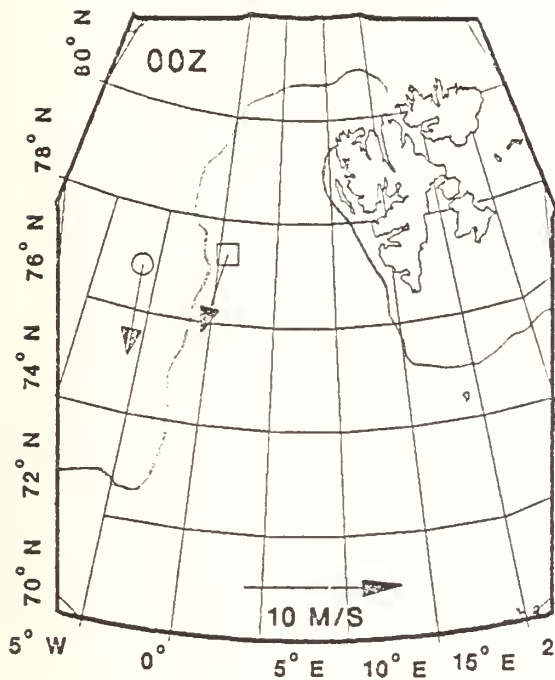




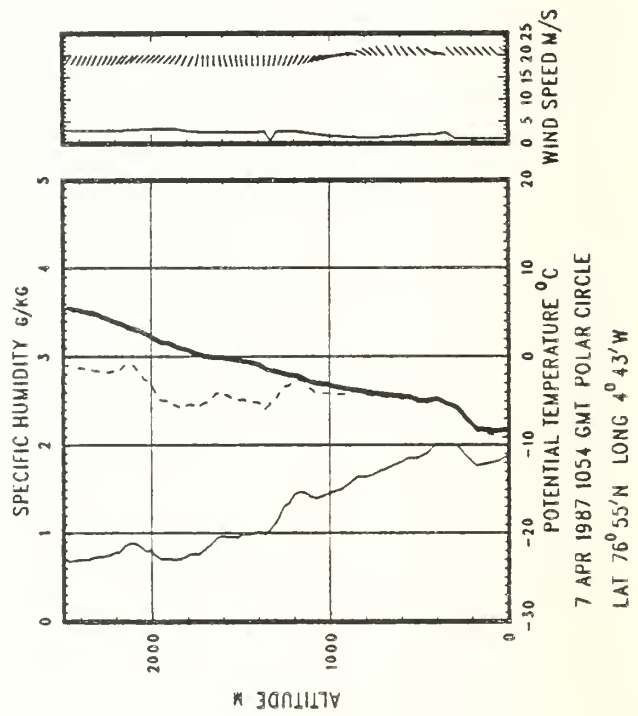
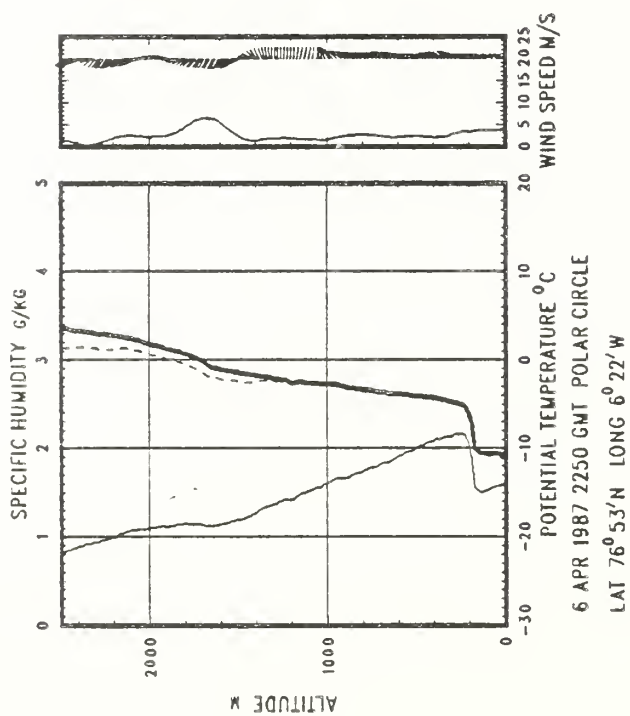
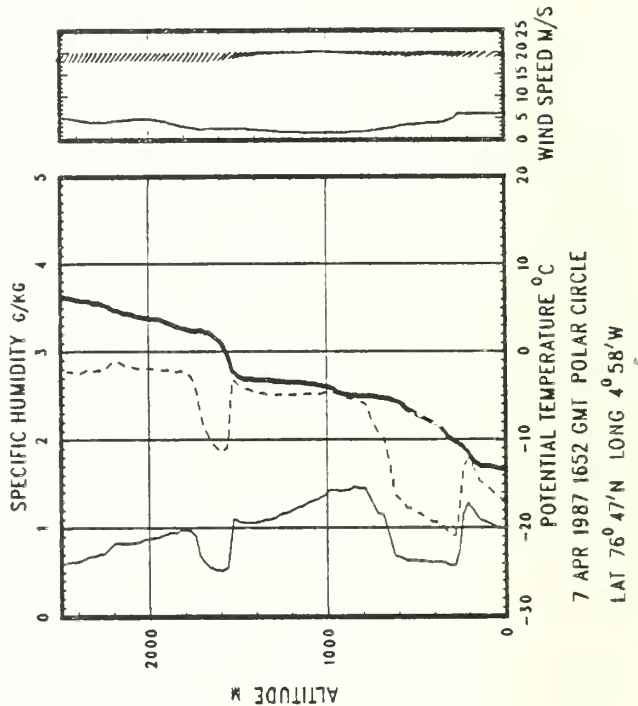
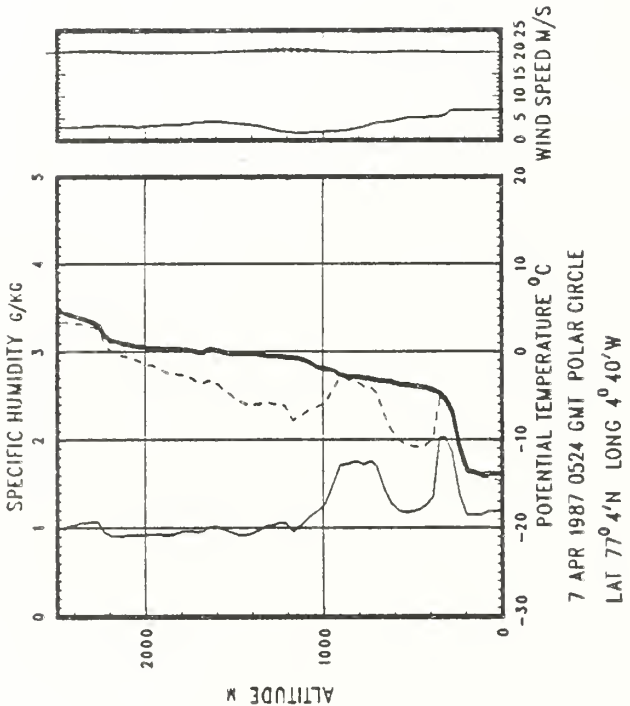
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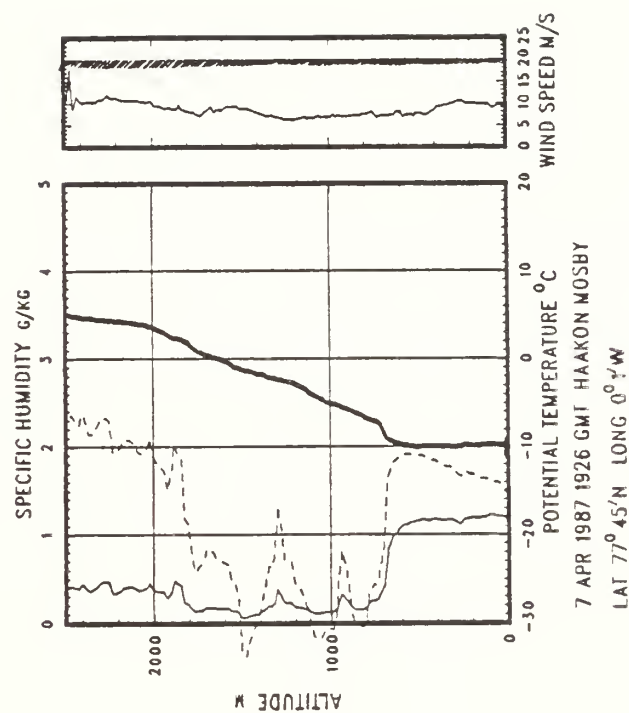
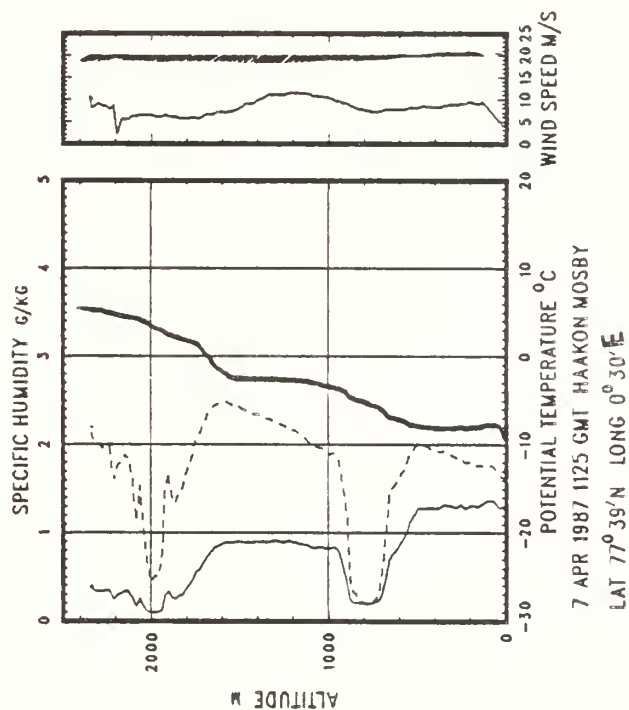
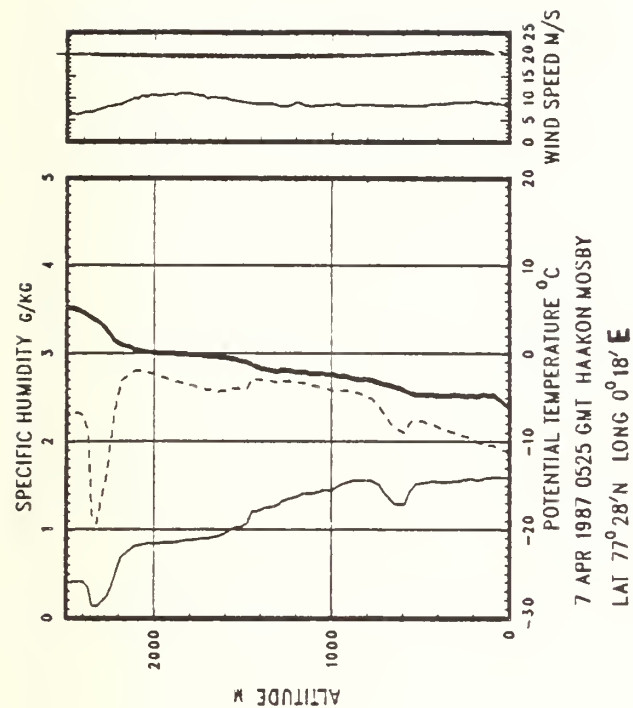
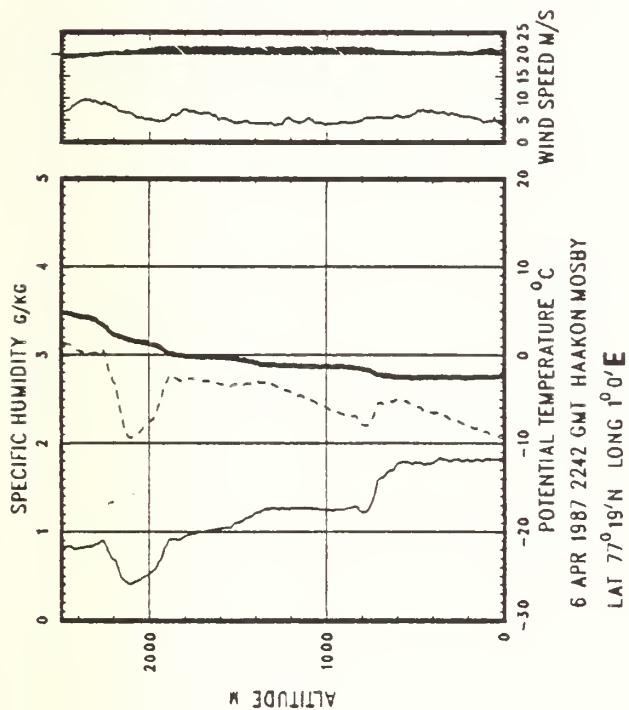


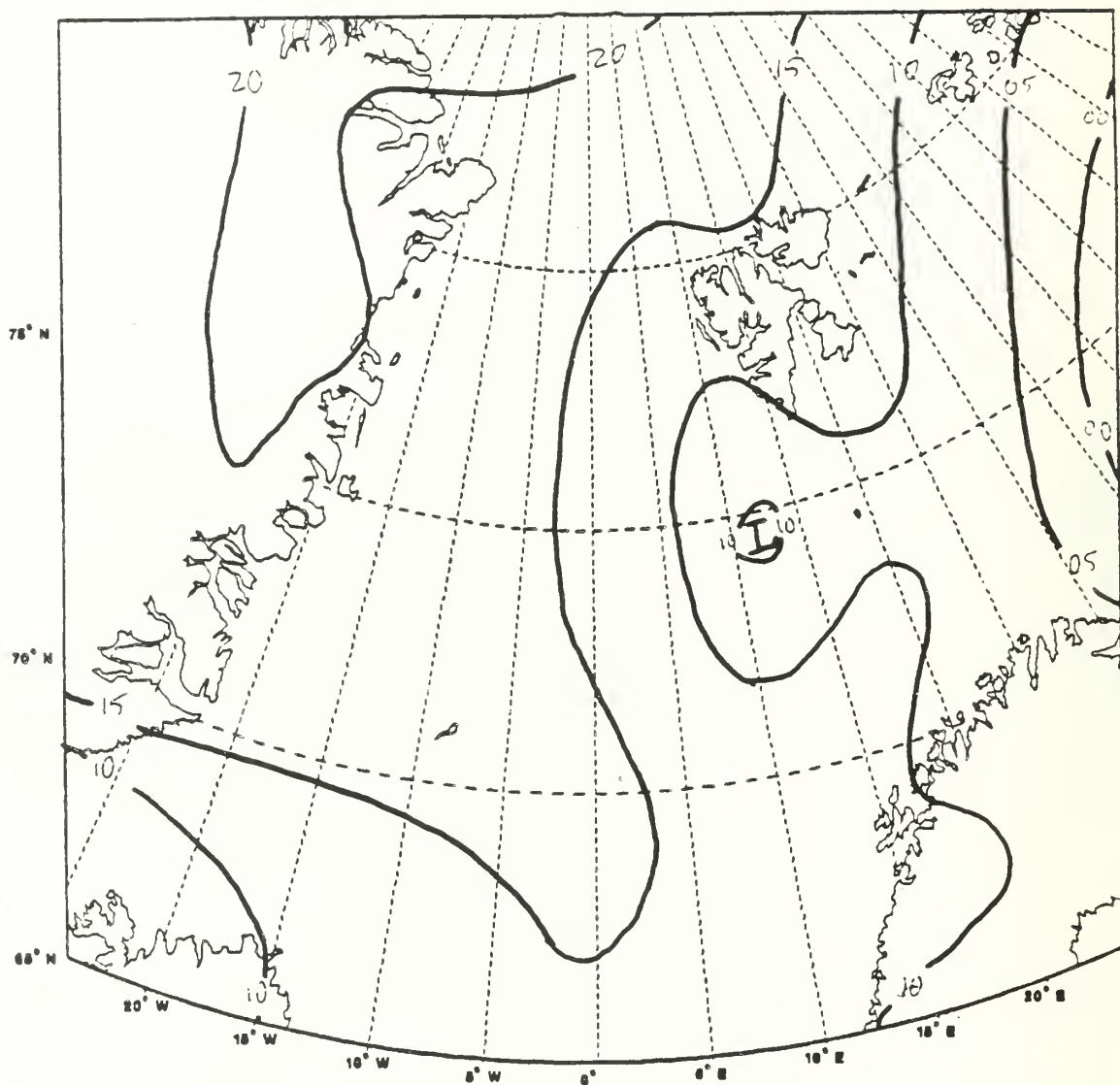
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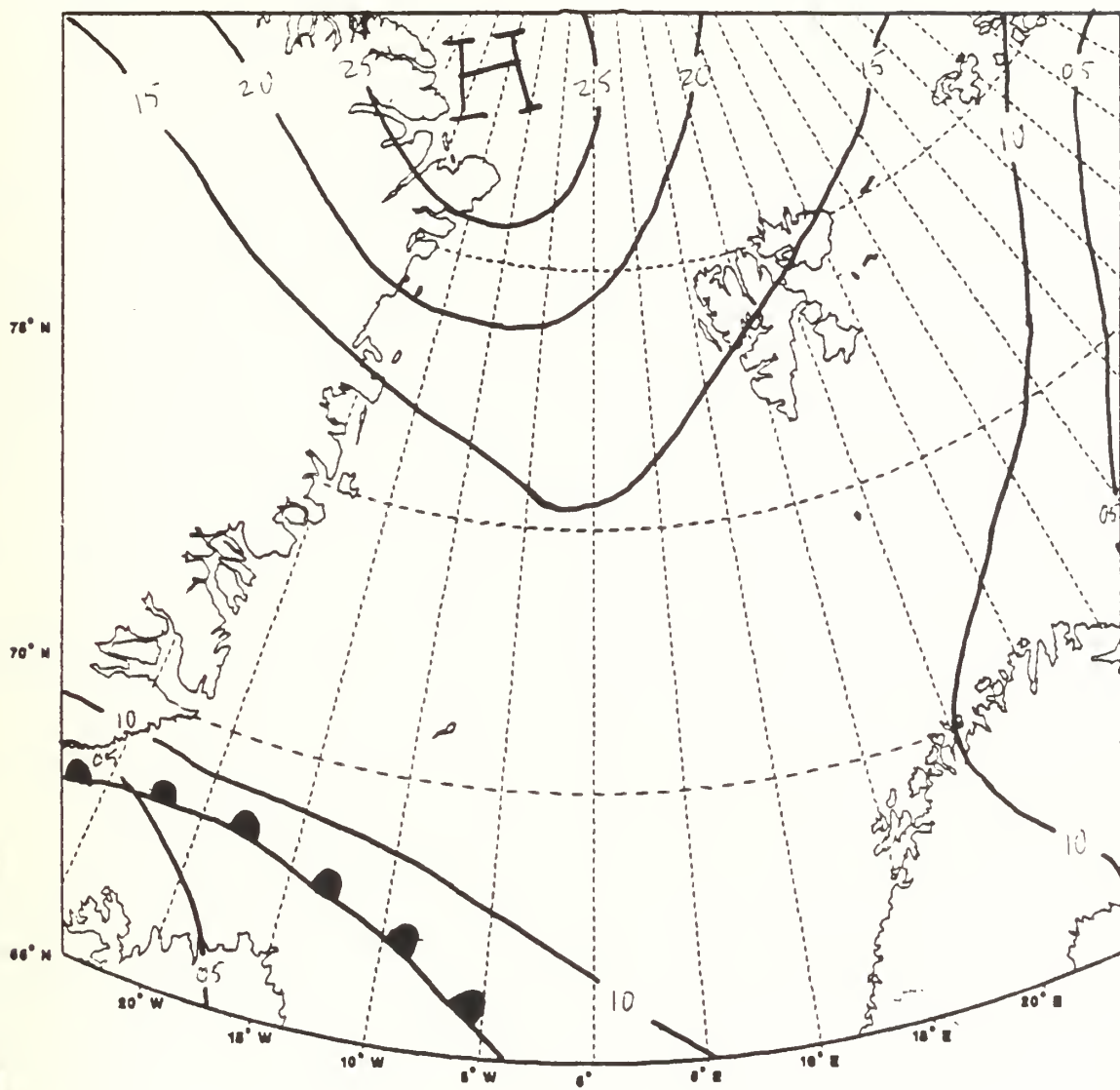
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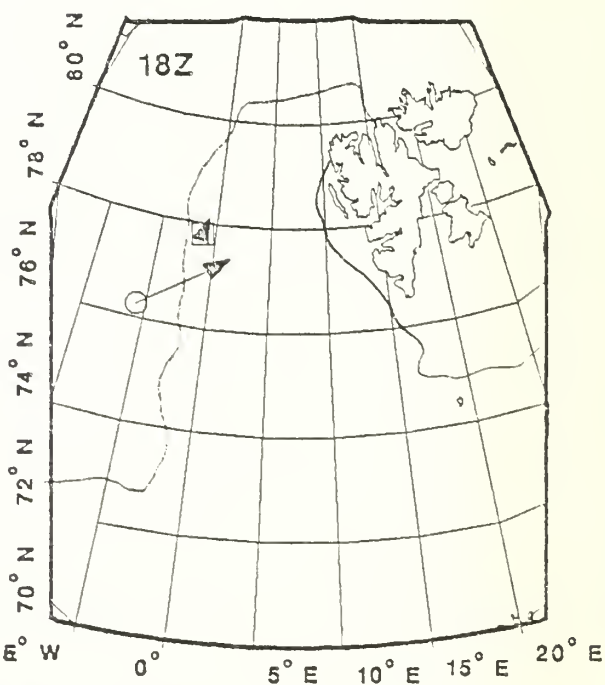
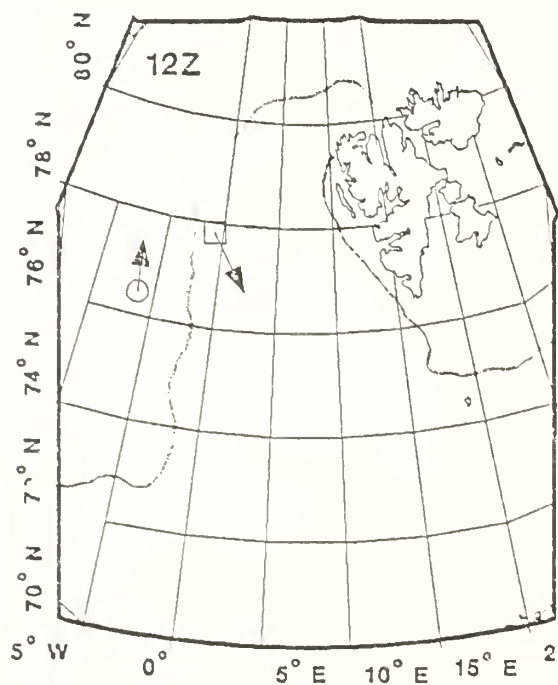
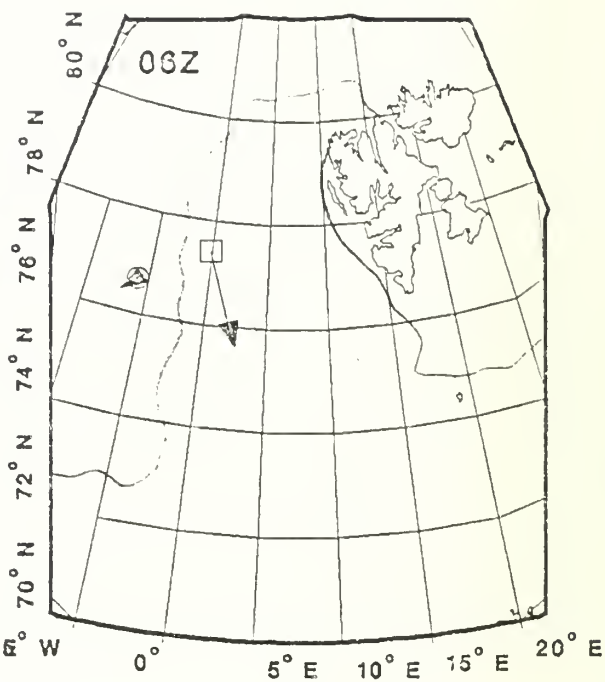
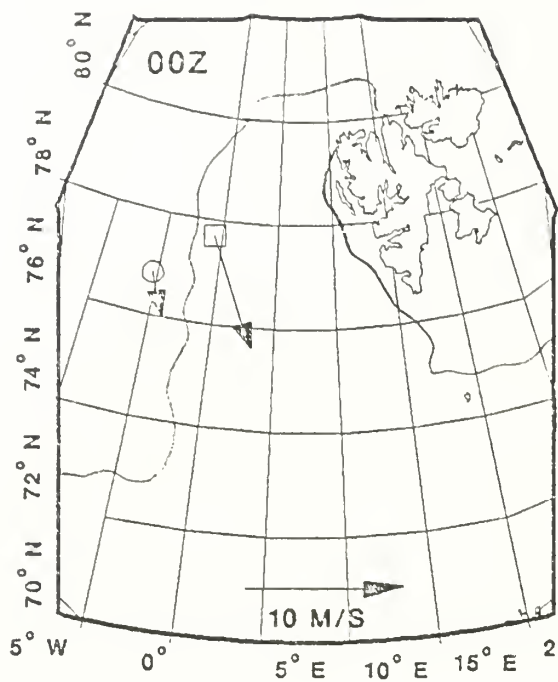




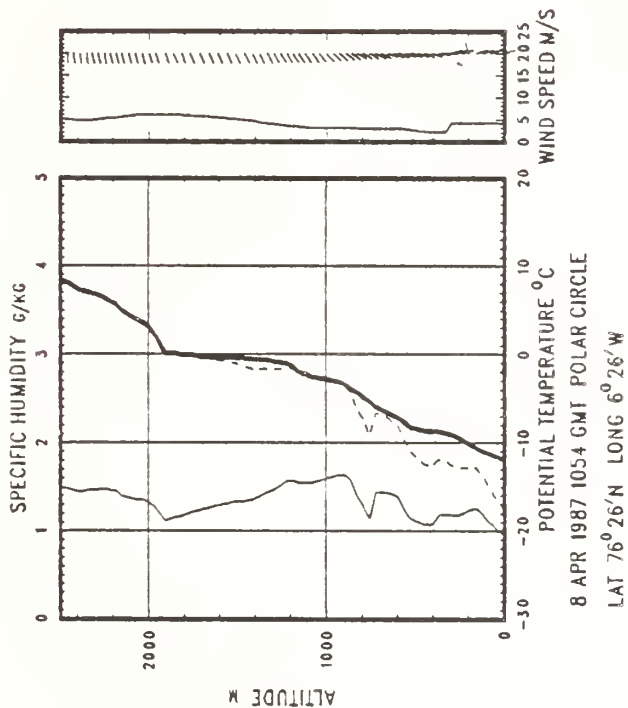
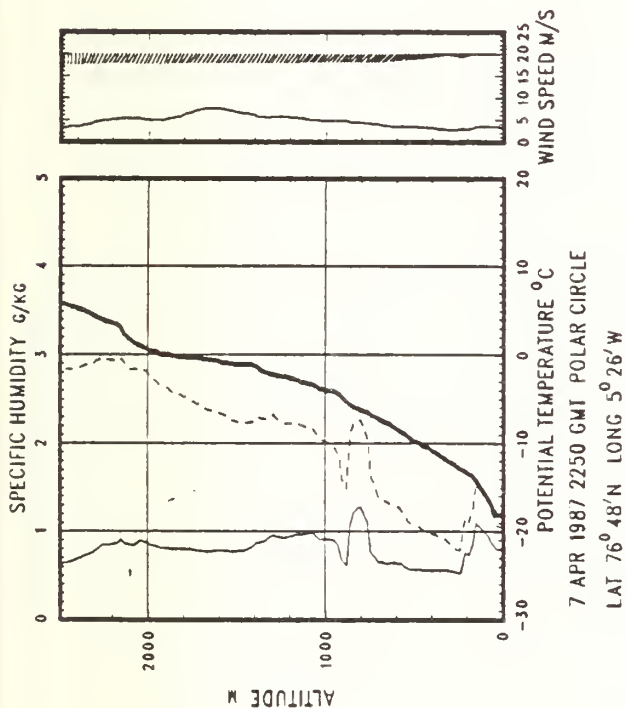
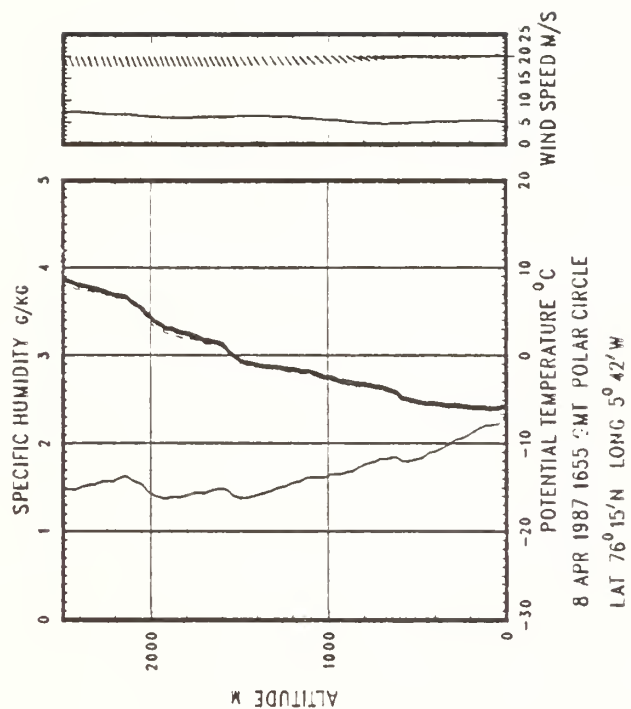
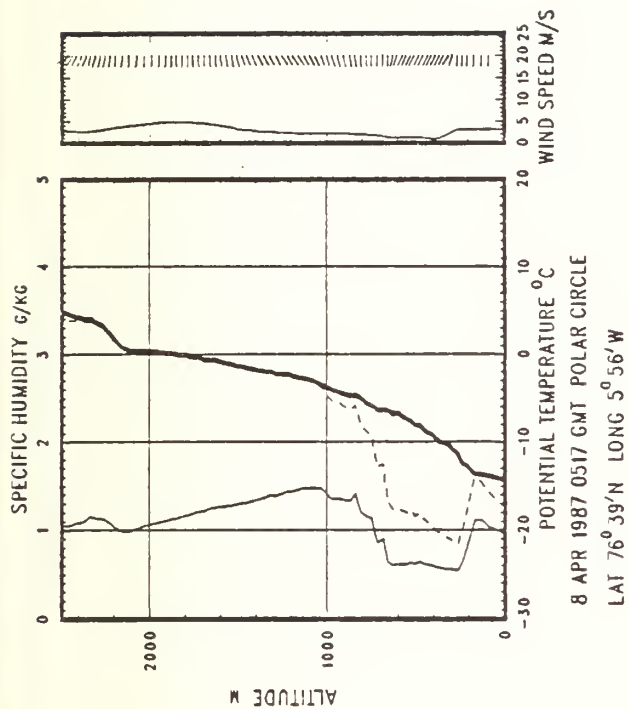
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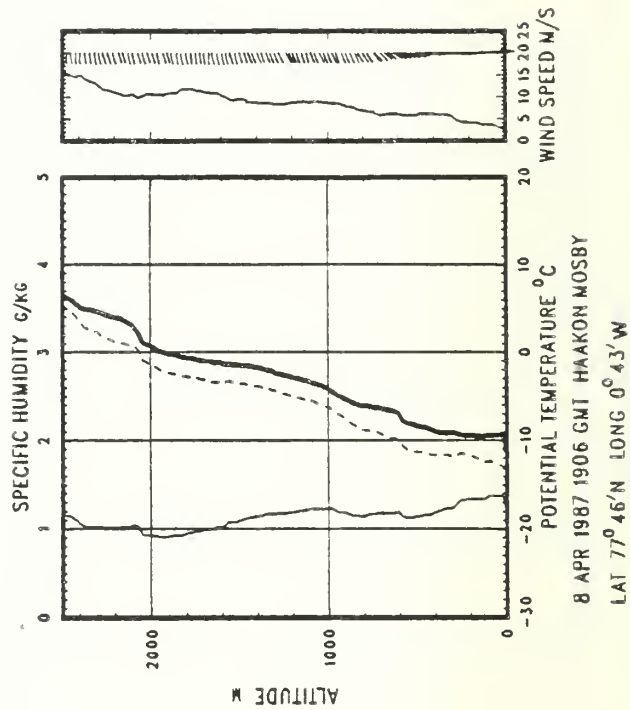
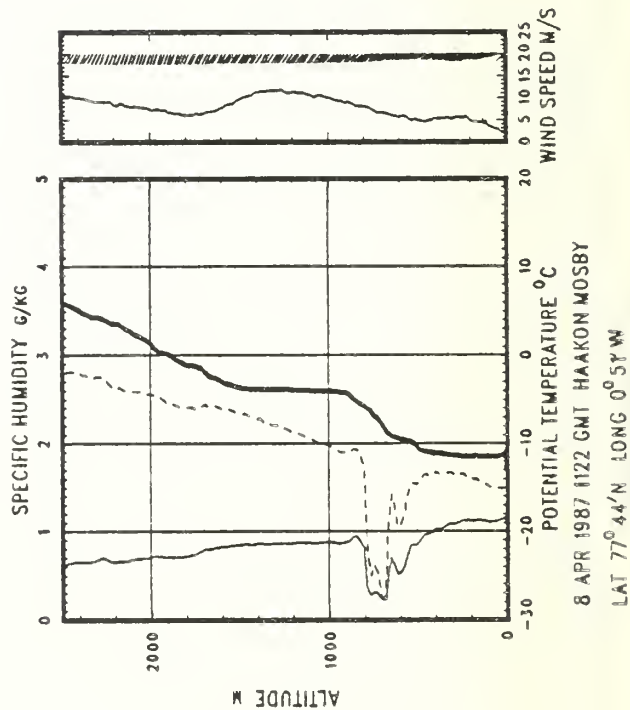
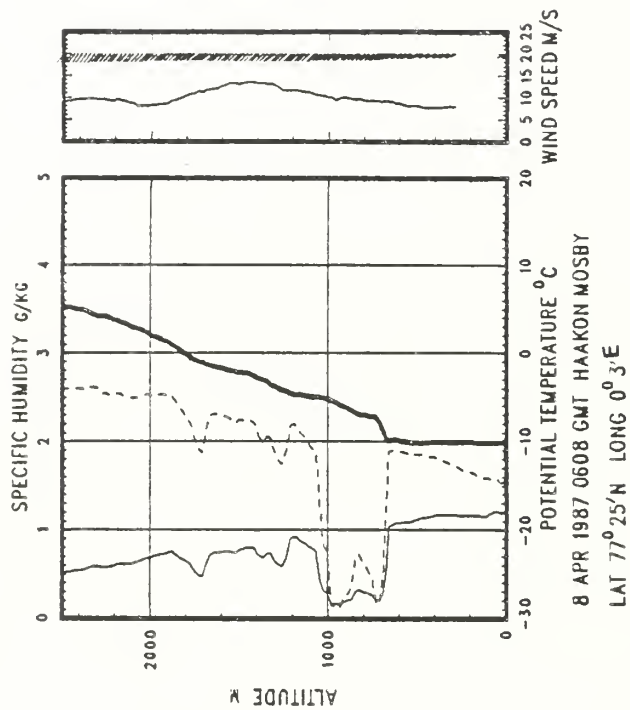
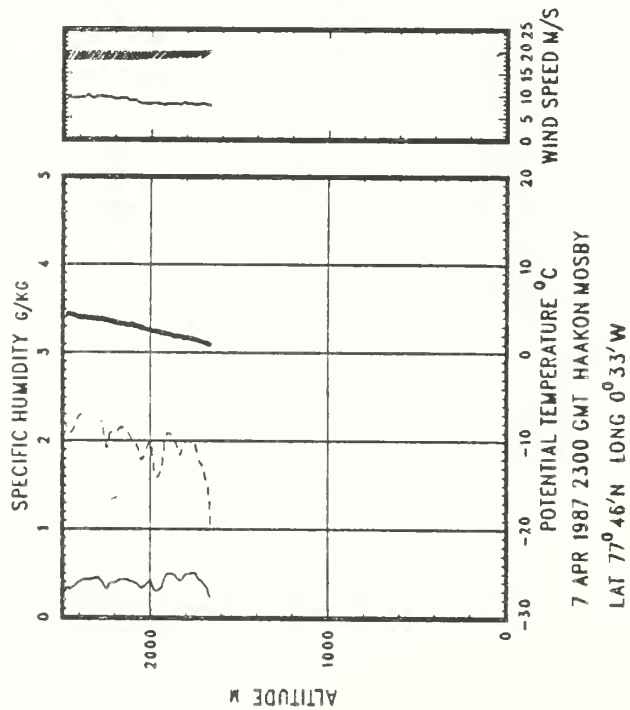


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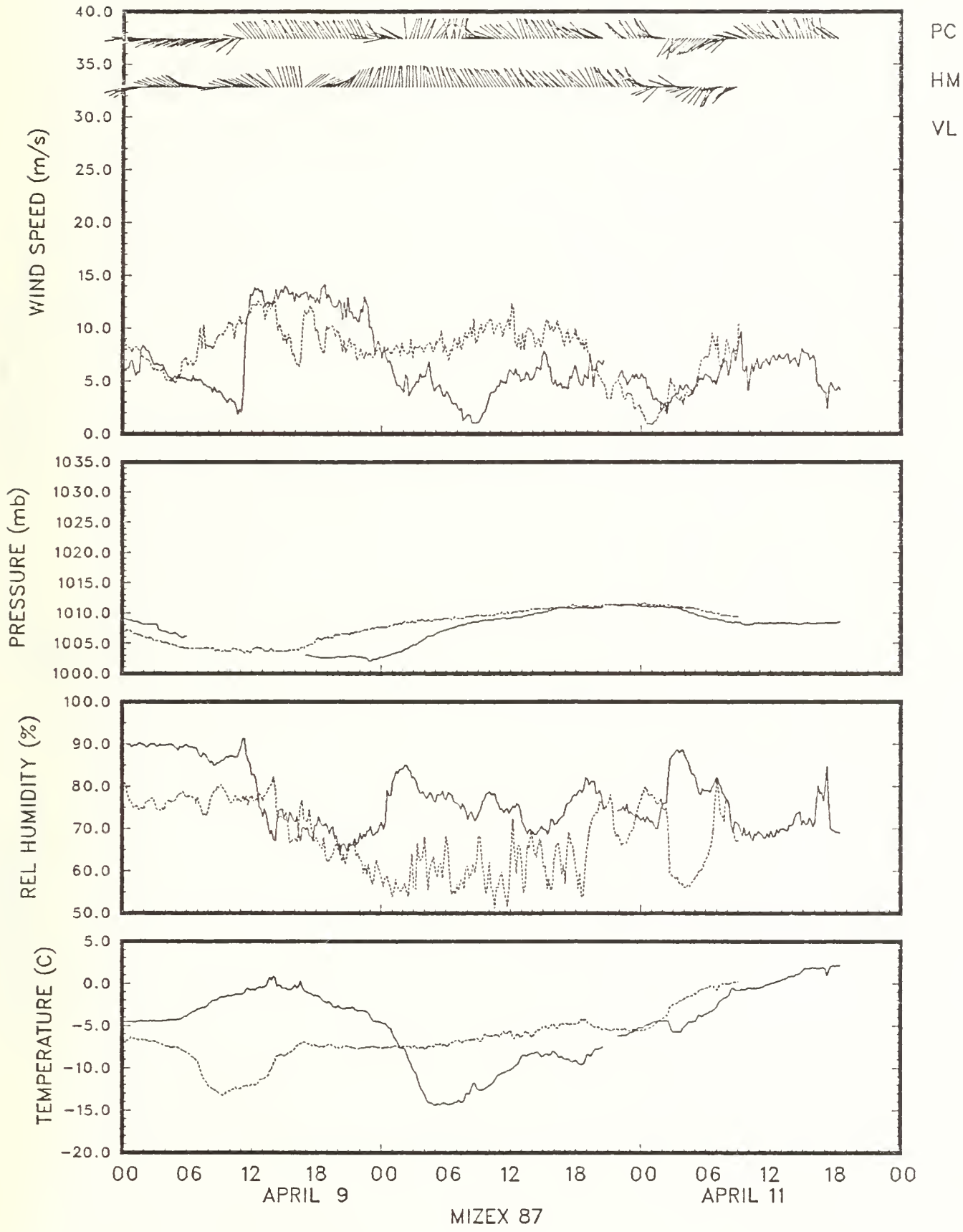


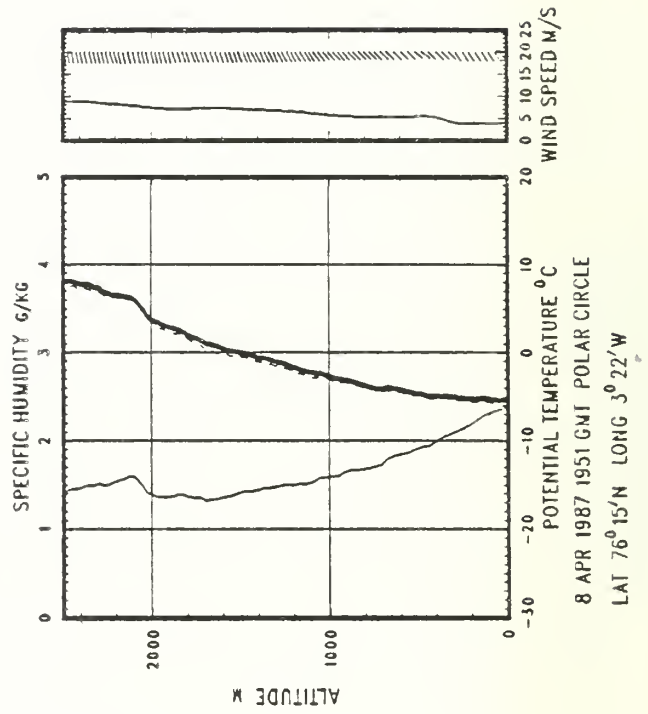
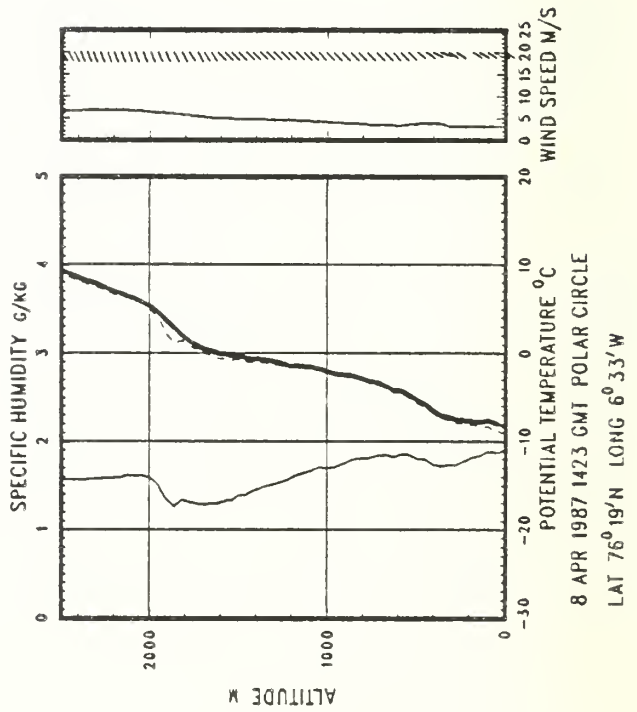
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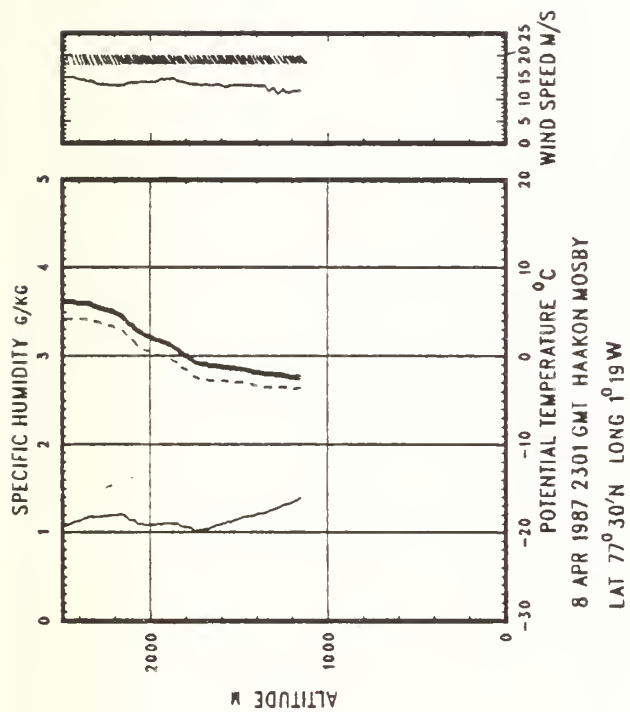


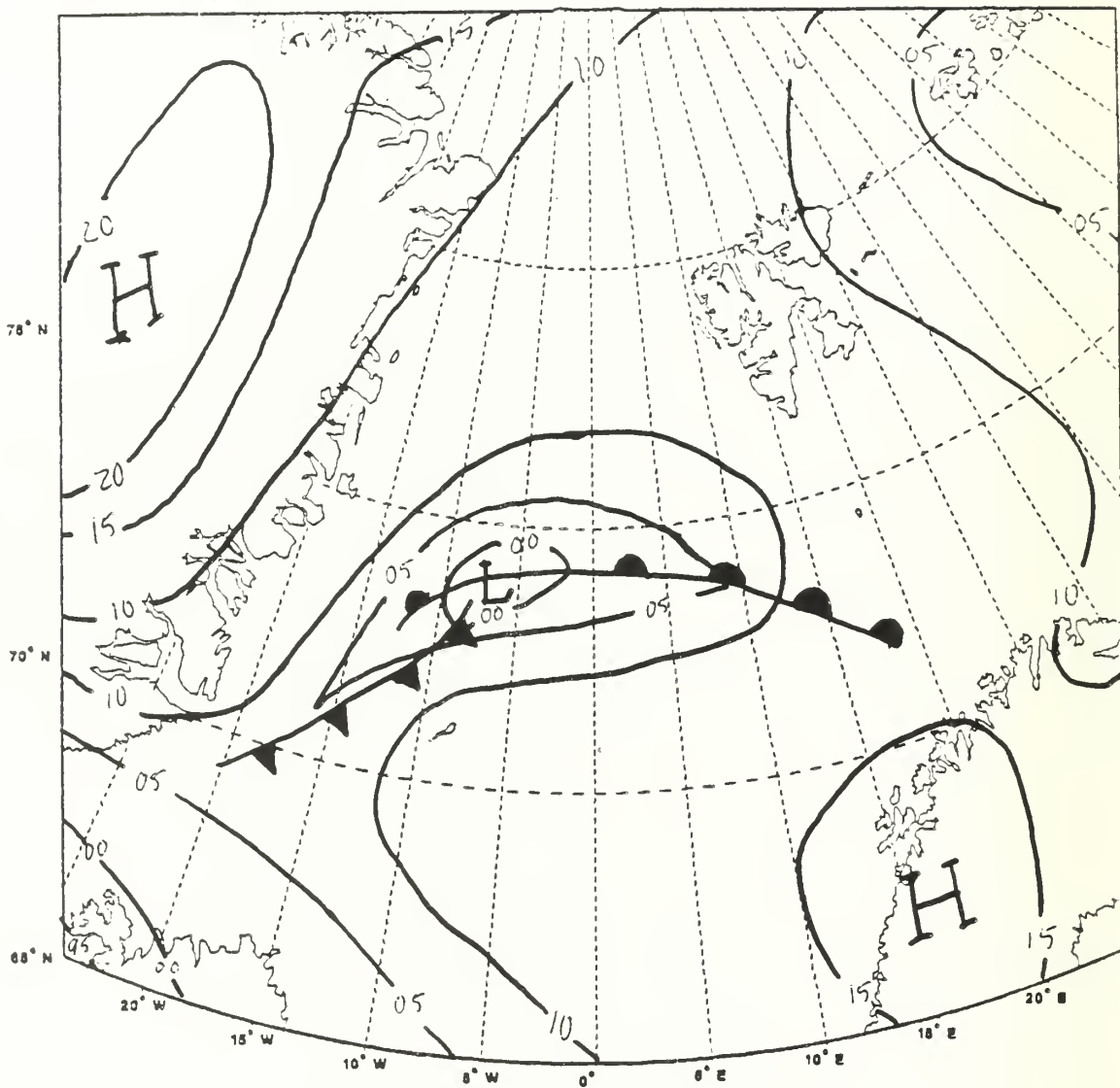


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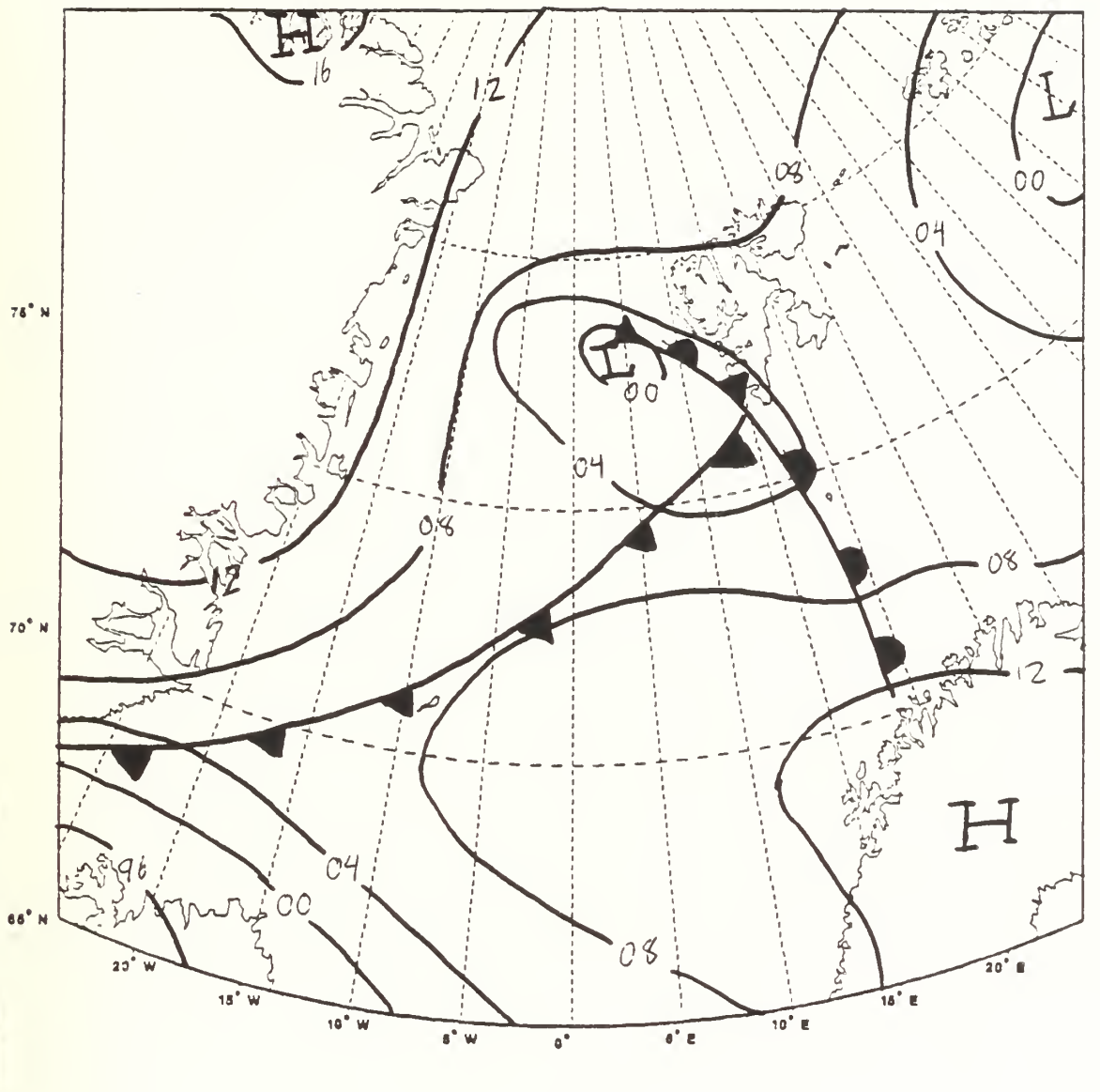




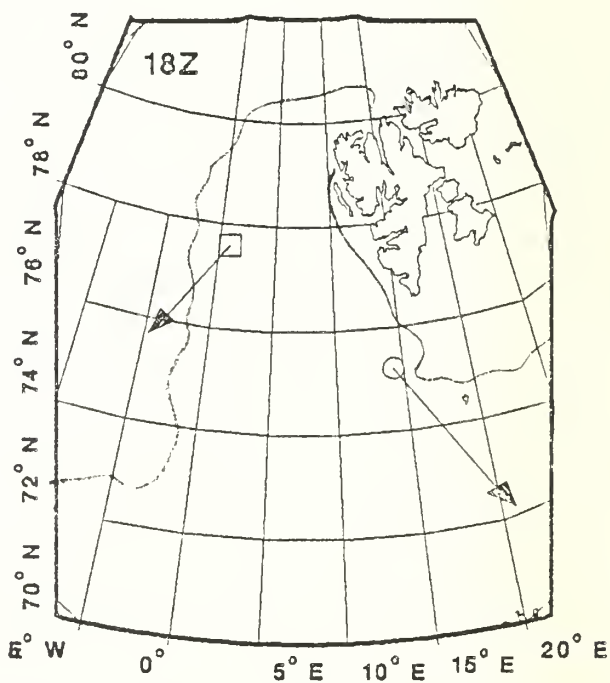
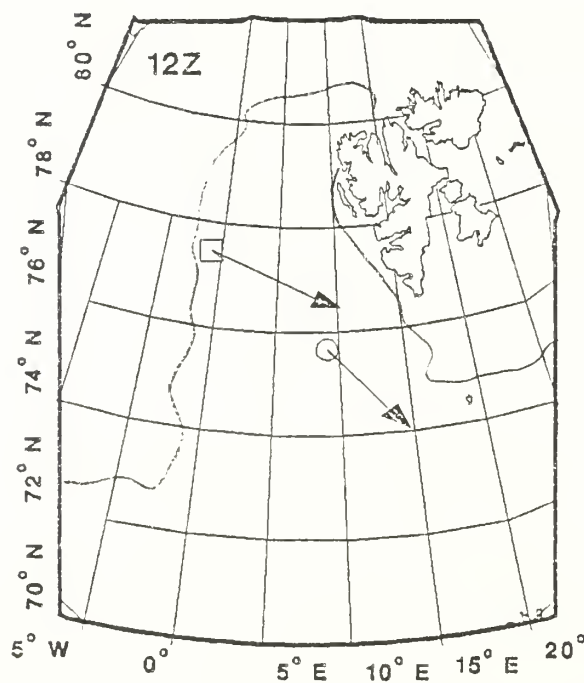
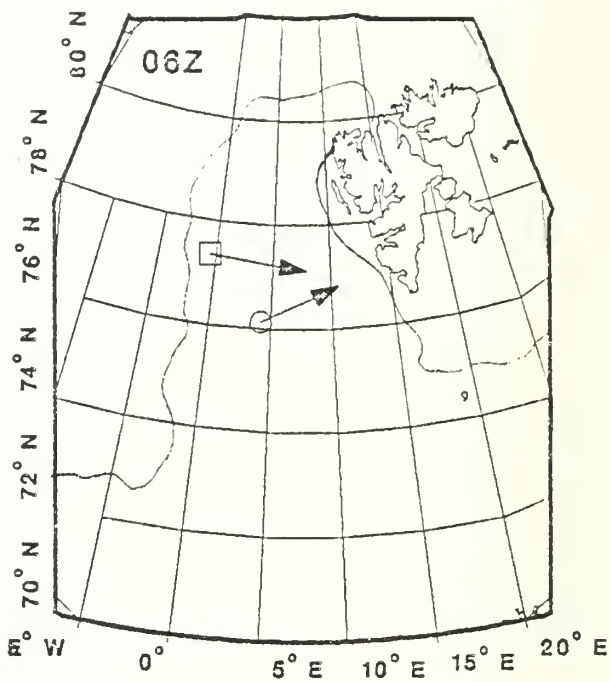
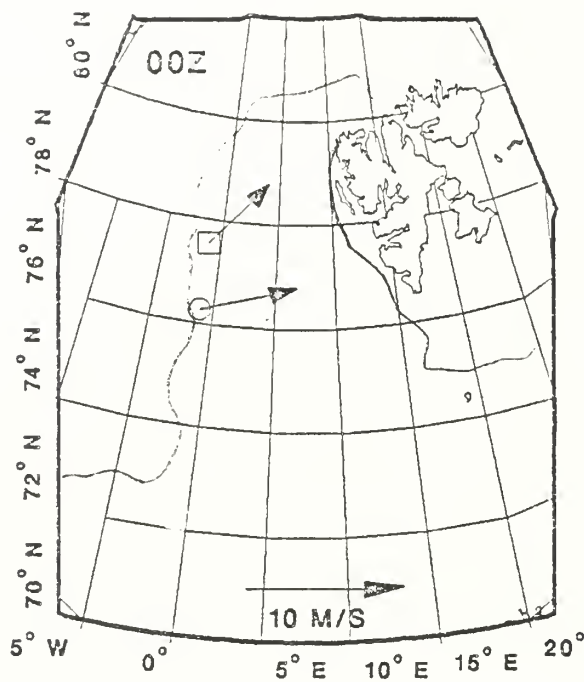




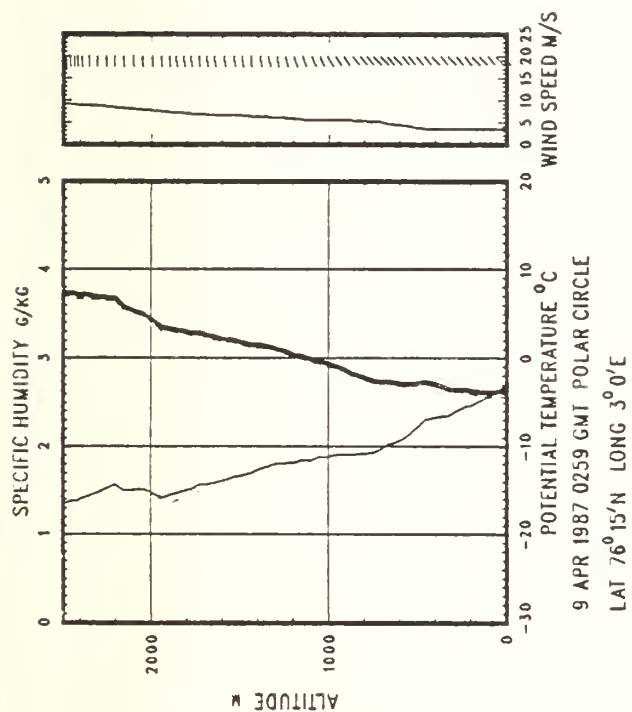
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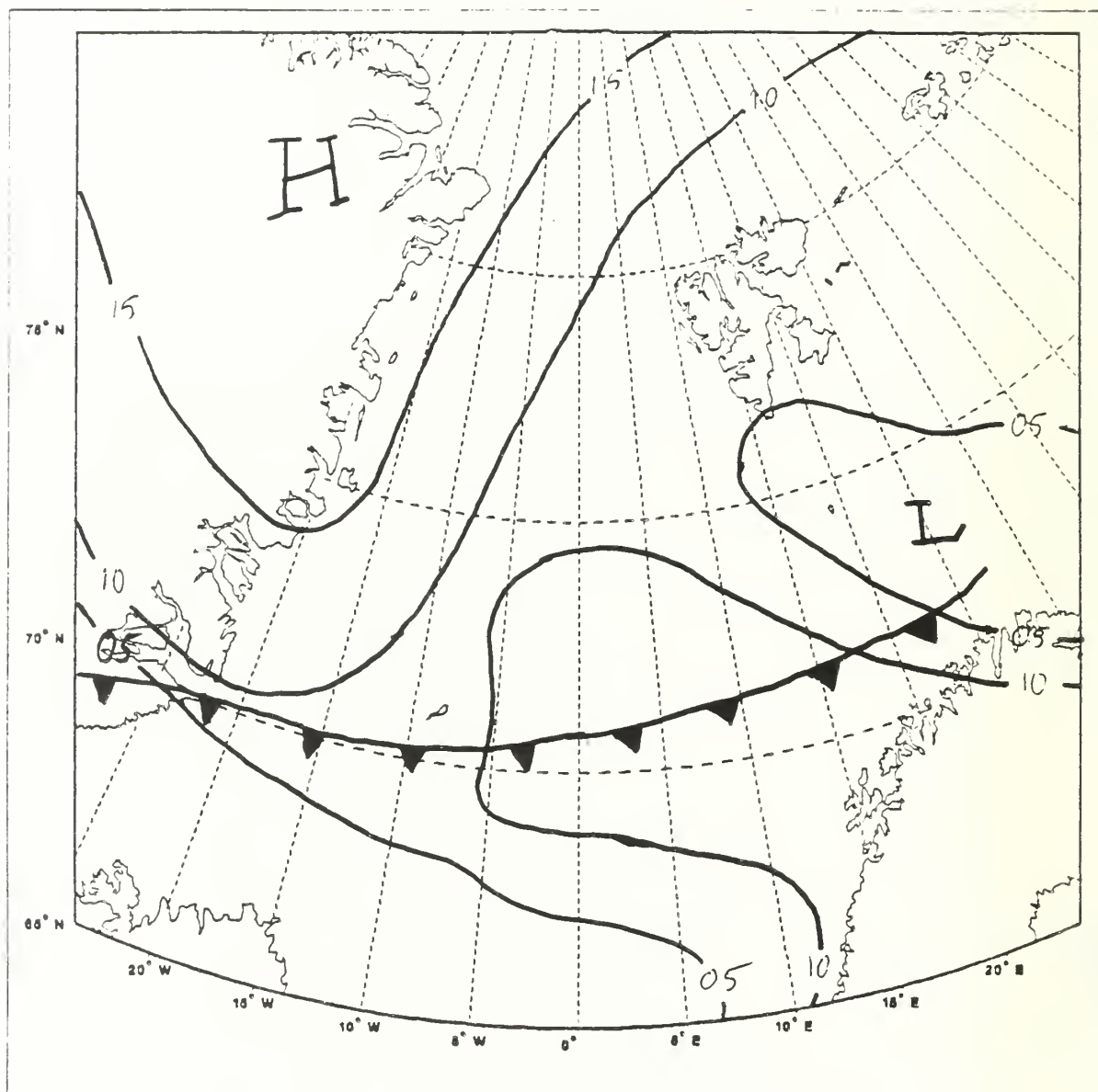


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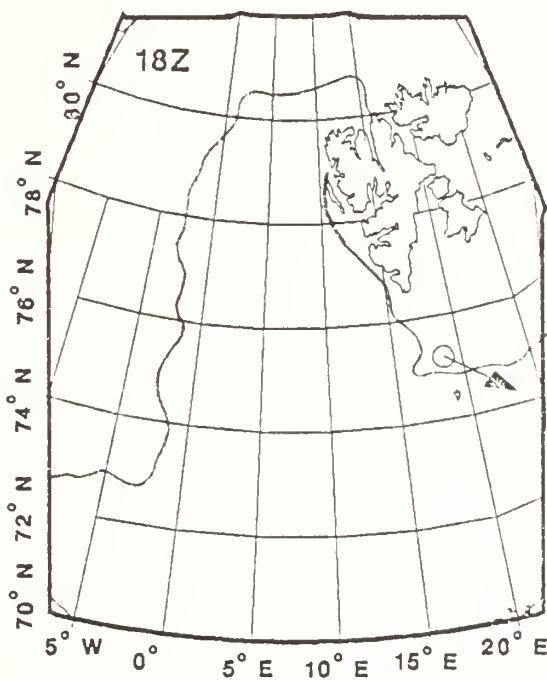
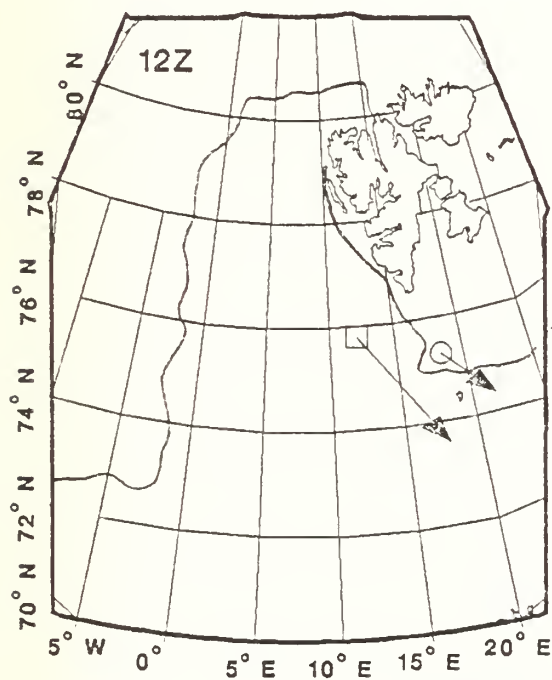
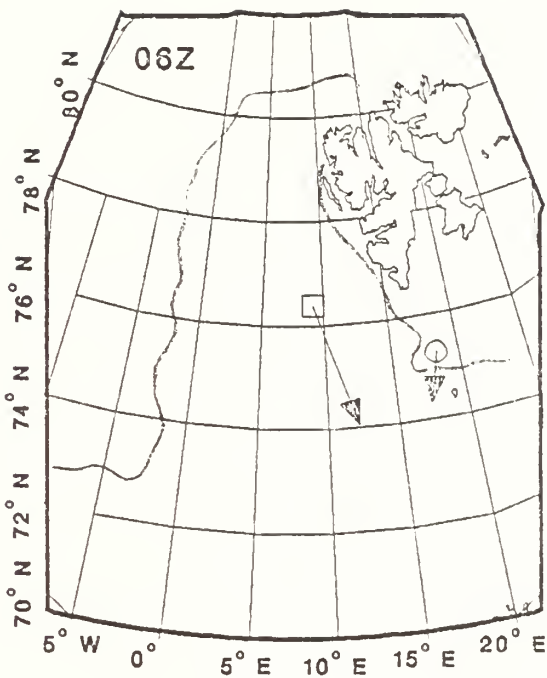
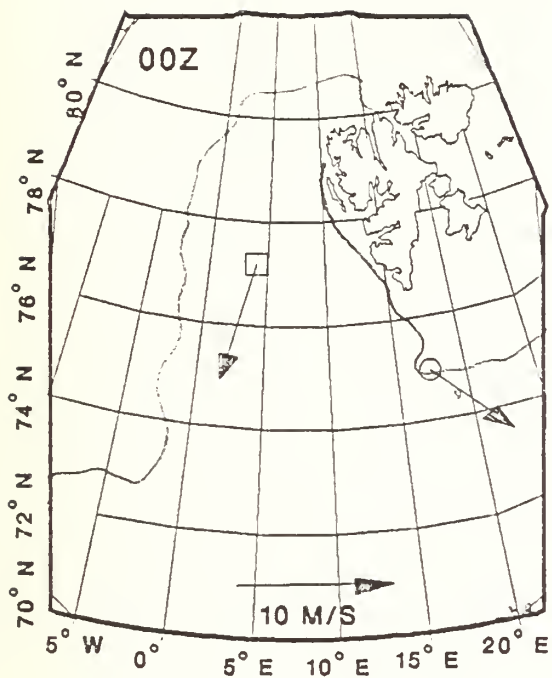


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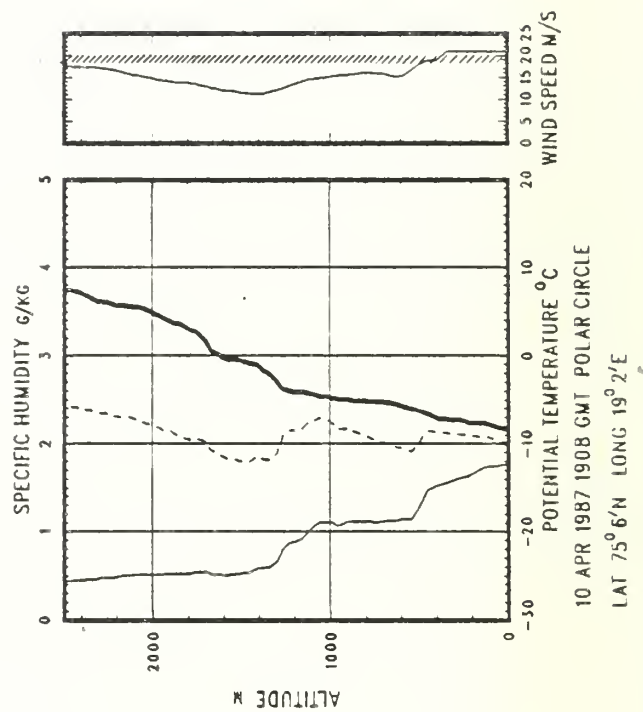
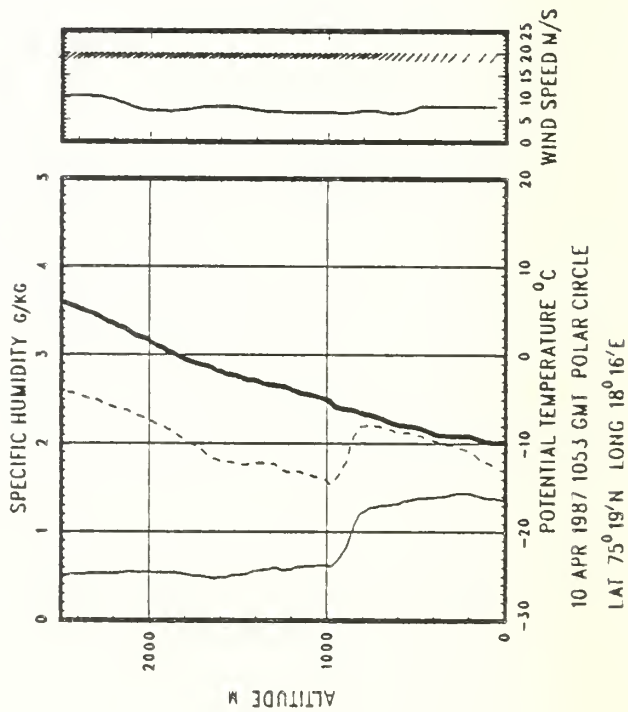


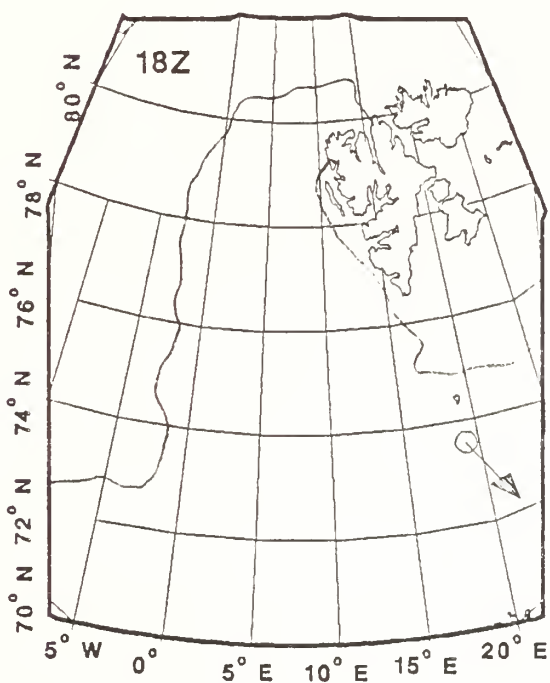
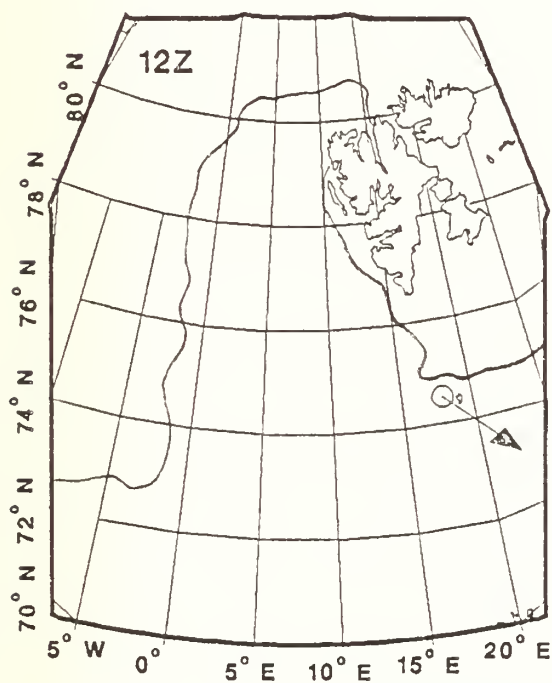
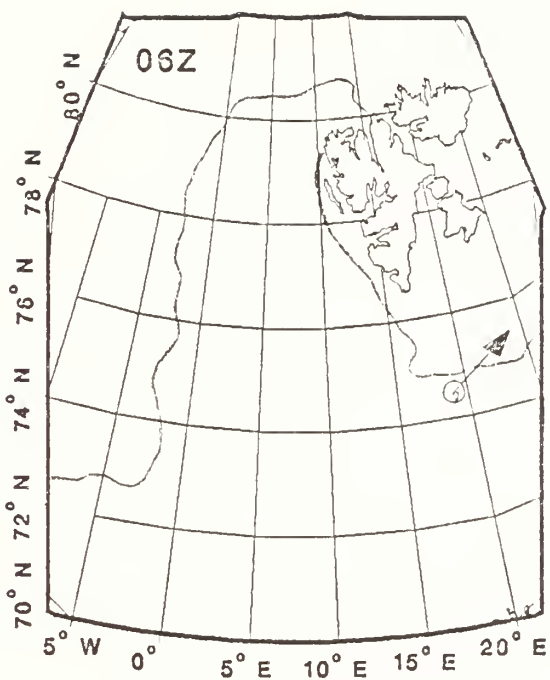
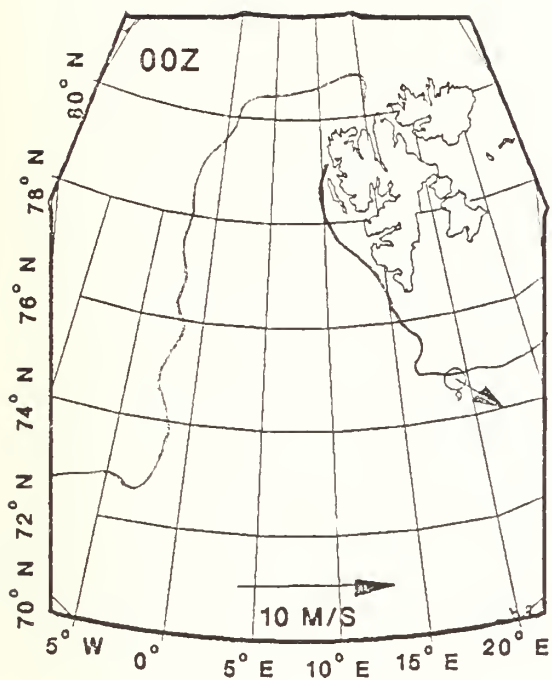


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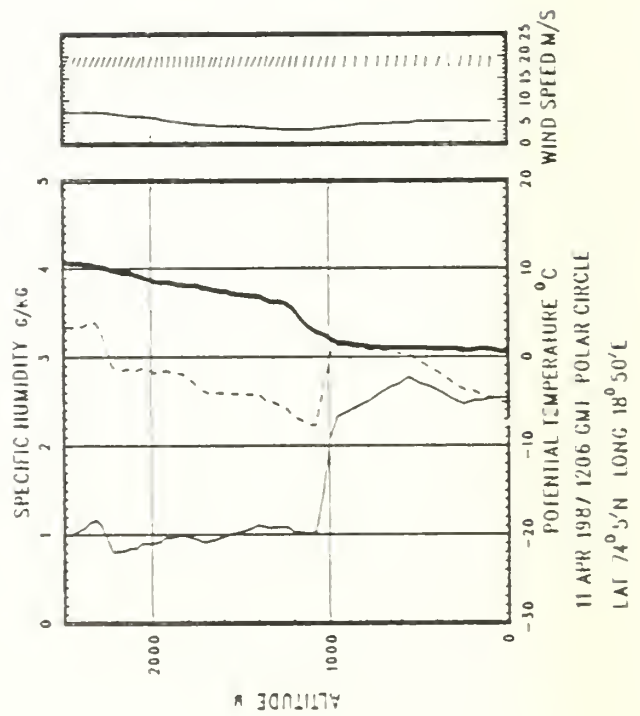
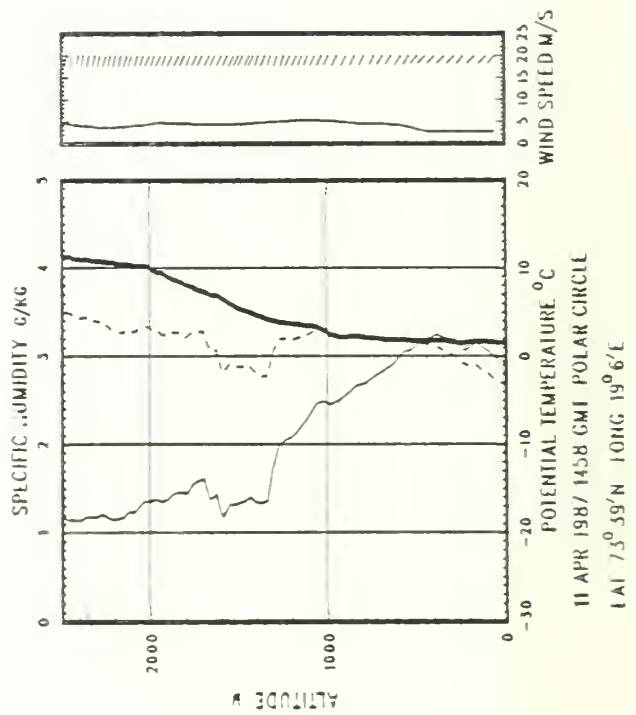
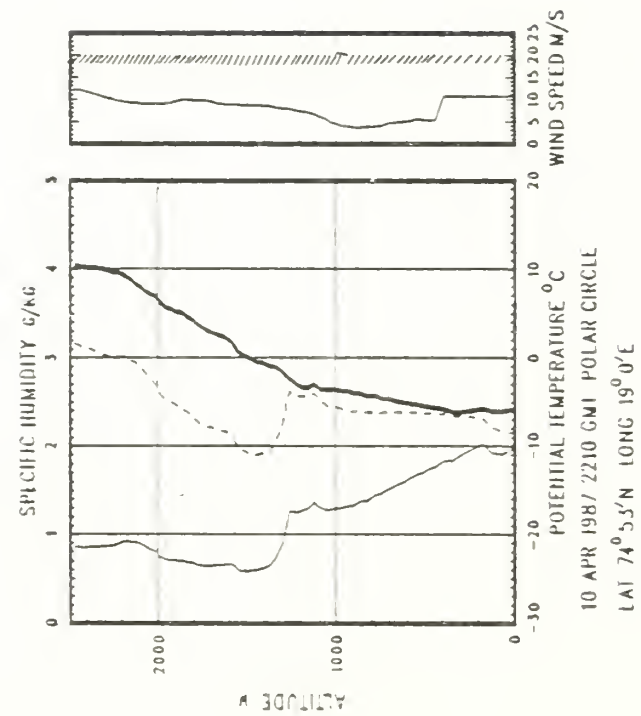


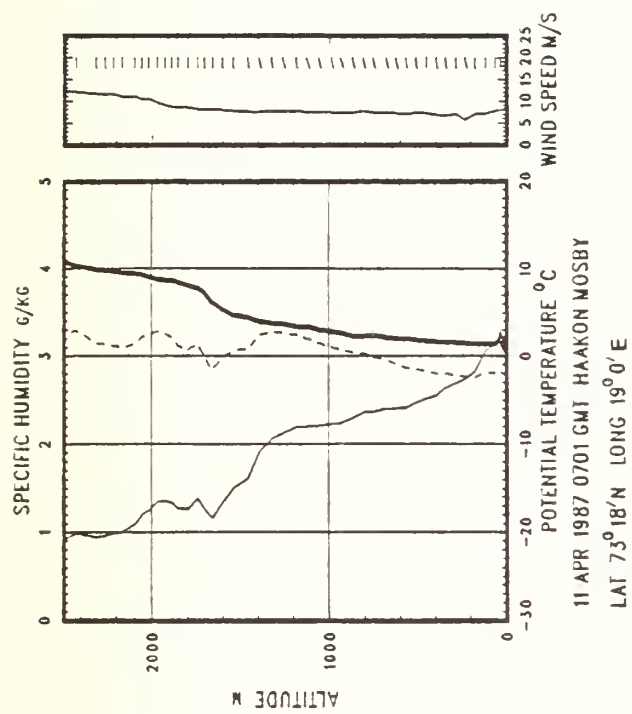
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Naval Observatory
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Max-Planck Inst for Meteorology
Bundestrasse 55
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Federal Republic of West Germany
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Department of Meteorology
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NOAA Wave Propagation Laboratory
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Norwegian Meteorological Institute
P.O. Box 320
Blindern
0314 Oslo 3
Norway
27. K. Wihelmsen 1
Norwegian Meteorological Institute
P.O. Box 2760
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9001 Tromso Norway
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